SnowEx: a NASA airborne campaign

leading to a snow satellite mission

SnowEx update: November 17, 2016

SnowEx Team/contributors to this report: Edward Kim, Charles Gatebe, Amy Misakonis, Dorothy Hall, DK Kang, HP Marshall, Ludovic Brucker, Kelly Elder, Chris Hiemstra, Lucas Spaete, Amanda Leon

Sponsored by NASA Headquarters/Terrestrial Hydrology Program Manager: Jared Entin

Agenda

- Welcome – Ed/Gatebe (3 min)
- Winter Ground Participants & Logistics
  - participant selection update/ground deployment plan/ snow survey (transect and snowpit) groups – Kelly Elder/Chris Hiemstra/HP Marshall – (5 min)
  - LSOS, SSA/SMP, GBRS groups - Ludo Brucker/HP Marshall – (5 min)
- Grand Mesa Terrestrial Laser Scanning (TLS)
  - Chris Hiemstra - (8 min)
  - Lucas Spaete - (7 min)
- Data Management
  - Amanda Leon - (20 min)
- Other topics
  - Schedule updates - Amy Misakonis (5 min)
  - Upcoming meetings and events - Dorothy Hall/DK Kang (2 min)
- Q&A

WINTER GROUND PARTICIPANTS & LOGISTICS

K.Elder/L. Brucker/HP Marshall/C.Hiemstra

NO CHANGE

GROUND MEASUREMENT TEAMS

People may work one, two, or three weeks, but **NO** partial weeks are possible. This requirement is based on safety, data quality and consistency, training requirements, travel logistics, and room and board availability.

The schedule is as follows:

Week 1 - Arrive at Grand Junction (Grand Mesa) Sunday, 2/5/17.
Training on Grand Mesa Monday, 2/6/17
Work Tuesday through Saturday, 2/11/17
Depart Grand Mesa morning Sunday, 2/12/17

Week 2 - Arrive at Grand Junction (Grand Mesa) Sunday, 2/12/17.
Training on Grand Mesa Monday, 2/13/17
Work Tuesday through Saturday, 2/18/17
Depart Grand Mesa morning Sunday, 2/19/17

Week 3 - Arrive at Grand Junction (Grand Mesa) Sunday, 2/19/17.
Training on Grand Mesa Monday, 2/20/17
Work Tuesday through Saturday, 2/25/17
Depart Grand Mesa morning Sunday, 2/26/17

NO CHANGE

Progress made

Team Selection Process

- We have ~~started~~ almost completed the team member selection process
  - Contacting all people that have filled out the participation surveys or notified us of intent to participate

    Done
  -
- Done Adding participants that are able to work within scheduled time blocks (weeks 1, 2 and 3)
-
- Done Contacting people who previously responded, but
  - Did not have coincident dates with schedule
  - Did not provide dates   Some still did not provide dates…

- Done Plan to have results out by November 15

Status
Everyone who stated a full week of availability was contacted by email on Nov. 15 to be a participant

Please respond to Amy with all information

Progress made

Ground-Based Remote Sensing
February 2017

A reminder about the GBRS survey results:
- 26 entries/instruments
- 25 unique instruments
- 24 different individuals

22 (out of 25) instruments are part of SnowEx

The 3 instruments not part of SnowEx year 1 are:
- high-end, long-range time-lapse cameras (but >80 low-cost, short-range cameras were deployed)
- a JPL radar (but it was installed at Fraser instead)
- some FMI's instruments due to the Snow Science Winter School in Sodankylä

In addition
GBRS statements of interest in the other surveys, emails, etc
have all been included for participation

30 people were notified on 11/15
for participation in GBRS activities

Ground-Based Remote Sensing

February 2017

- Microwave radiometer
- Radar
- Scatterometer
- Terrestrial Lidar
- Spectroradiometer
- Goniometer
- GPS
- Tree accelerometer
- Time lapse camera
- Precipitation instruments
- Snow depth sensors

Colors refer to existing groups (with phone calls, shared documents, …)

Shared documents → SnowEx experiment plan

Based on each group progress, cross group calls will be scheduled for coordination, etc.

SELECTED PARTICIPANTS

Grand Mesa/Senator Beck Winter Participants

Week 1

1	Paul	Houser
2	Timbo	Stillinger
3	Carrie	Vuyovich
4	Anne	Nolin
5	Mary Jo	Brodzik
6	Nicholas	Wayand
7	Chris	Polashenski
8	Travis R.	Roth
9	Keith	Musselman
10	Elias	Deeb
11	Glen	Liston
12	Leonna	Merkouriadi
13	Keith	Jennings
14	Dean	Howard
15	Nick	Wright
16	Theodore	Barnhart
17	Angus	Goodbody
18	Amaya	Odiaga
19		
20		

Week 2

1	Paul	Houser
2	Timbo	Stillinger
3	Carrie	Vuyovich
4	Arvids	Silis
5	Markus	Todt
6	Eric	Keenan
7	Jessica	Lundquist
8	Anna	Wagner
9	J. Andrew	Gleason
10	Andrew	Klein
11	Oliver	Wigmore
12	Zoe	Courville
13	Andrew	Hedrick
14	Lora	Koenig
15	Amaya	Odiaga

Week 3

1	Paul	Houser
2	Timbo	Stillinger
3	Arvids	Silis
4	Markus	Todt
5	Carlos	Diaz
6	William	Currier
7	Joel A.	Gongora
8	Justin	Pflug
9	Mark	Raleigh
10	Adrian	Harpold
11	Ryan	Lee
12	Karl	Lapo
13	Marco	Tedesco
14	Banning	Starr

	MGMT	
1	Hans Peter	Marshall
2	Christopher	Hiemstra
3	Ludovic	Brucker
4	Kelly	Elder
	SENATOR BECK	
1	Hans Peter	Marshall
2	Andy	Gleason
3	Scott	Havens
4	Andrew	Hedrick
5	Chago	Rodriguez
6	Ned	Bair
7	Patrick	Kormos
8	Zoe	Coreville
9	Karl	Rittger
10	Jeffrey	Deems
11	Pete	Gadonski
12	Ty	Brandt

GBRS PARTICIPANTS

			Su	M	T	W	TH	F	S	SU	M	T	W	TH	F	S	SU	M	T	W	TH	F	S	S
First name	**Last name**		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
GBRS																								
Mohammad	Mousavi	LSOS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Jiyue	Zhu	LSOS	x	x	x	x	x	x	x	x														
Weihui	Gu	LSOS	x	x	x	x	x	x	x	x														
Shurun	Tan	LSOS															x	x	x	x	x	x	x	x
DK	Gang																x	x	x	x	x	x	x	x
			0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	
Nancy	Glenn	TLS	x	x	x	x	x	x	x	x														
Lucas	Spaete	TLS	x	x	x	x	x	x	x	x									x	x	x	x	x	x
Zach	Uhlmann	TLS	x	x	x	x	x	x	x	x							x	x	x	x	x	x	x	x
Chris	Tennant	TLS															x	x	x	x	x	x	x	x
Art	Gelvin	TLS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
McKenzie	Skiles	ASD								x	x	x	x	x	x	x	x							
Christopher	Crawford	ASD								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Liuxi	Tian	ASD															x	x	x	x	x	x	x	x
John H.	Bradford	Radar																						
Travis	Nielson	Radar																						
Ryan	Webb	Radar	x	x	x	x	x	x	x	x														
Dan	McGrath	Radar								x	x	x	x	x	x	x	x							
John F.	Burkhart	Radar	x	x	x	x	x	x	x	x														
Havard	Erikstrod	Radar	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Michael	Durand	PMW/SSA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Jinmei	Pan	PMW/SSA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Rhae Sung	Kim	PMW/SSA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Alex	Langlois	PMW								x	x	x	x	x	x	x	x							
Alexandre	Roy	PMW								x	x	x	x	x	x	x	x							
Richard	Kelly	Scatt															x	x	x	x	x	x	x	x
Aaron	Thompson	Scatt															x	x	x	x	x	x	x	x
Adam	Lewinter	ULS																						
Dave	Finnegan	ULS																						
			0	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	
SSA/SMP																								
Nick	Rutter									x	x	x	x	x	x	x	x							
Tom	Watts																x	x	x	x	x	x	x	x
Mel	Sandells										x	x	x	x	x									
Chris	Derksen									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Joshua	King									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Andrew	Giunta									x	x	x	x	x	x	x	x							
Michaela	Teich									x	x	x	x	x	x	x	x							

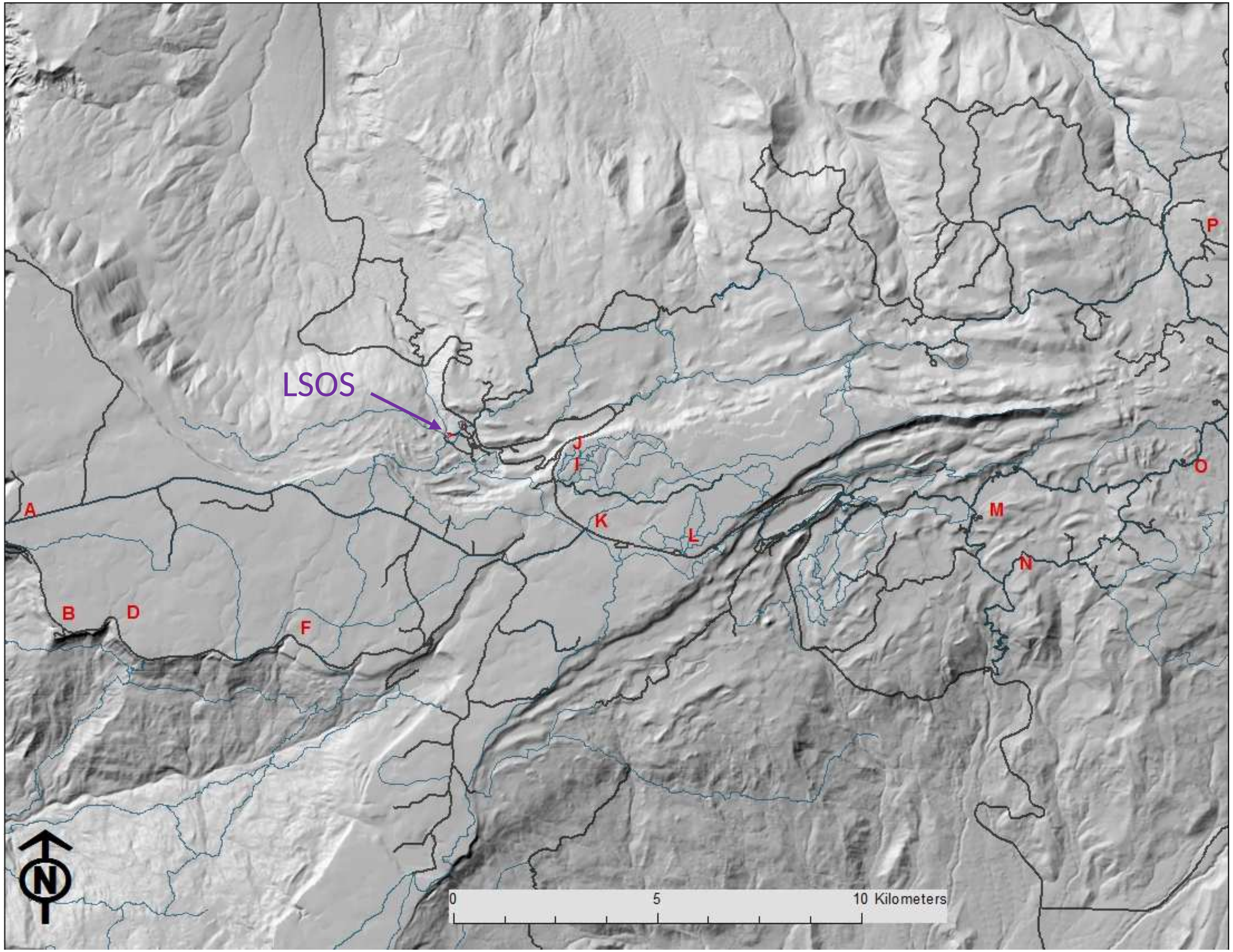
TERRESTRIAL LASER SCANNING (TLS)

Grand Mesa Terrestrial Laser Scanning (TLS) Overview and Data Collection

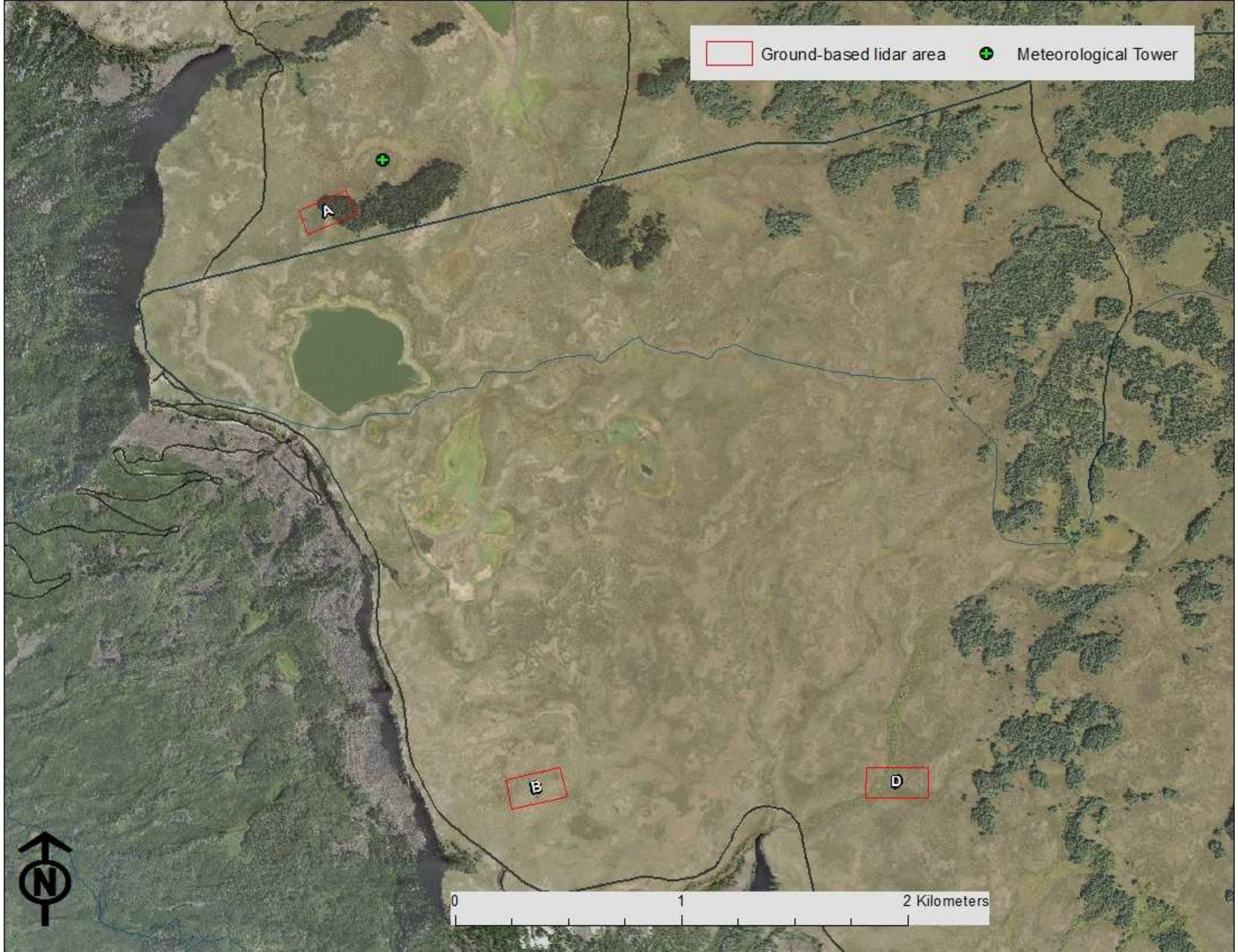
Chris Hiemstra, Lucas Spaete, Jeff Deems, Pete Gadomski, Nancy Glenn, Anne Marie Raymondi, Art Gelvin, Ludo Brucker

Grand Mesa
TLS Re-cap

- 14 sites distributed across Grand Mesa
  - Roads are black, trails blue
- Roughly 100 by 200 m in area
  - Smaller in forested areas
- Captures gradients/transitions from open to forest.
- Placed around or hosting infrastructure (e.g., reflectors, towers, sensors)

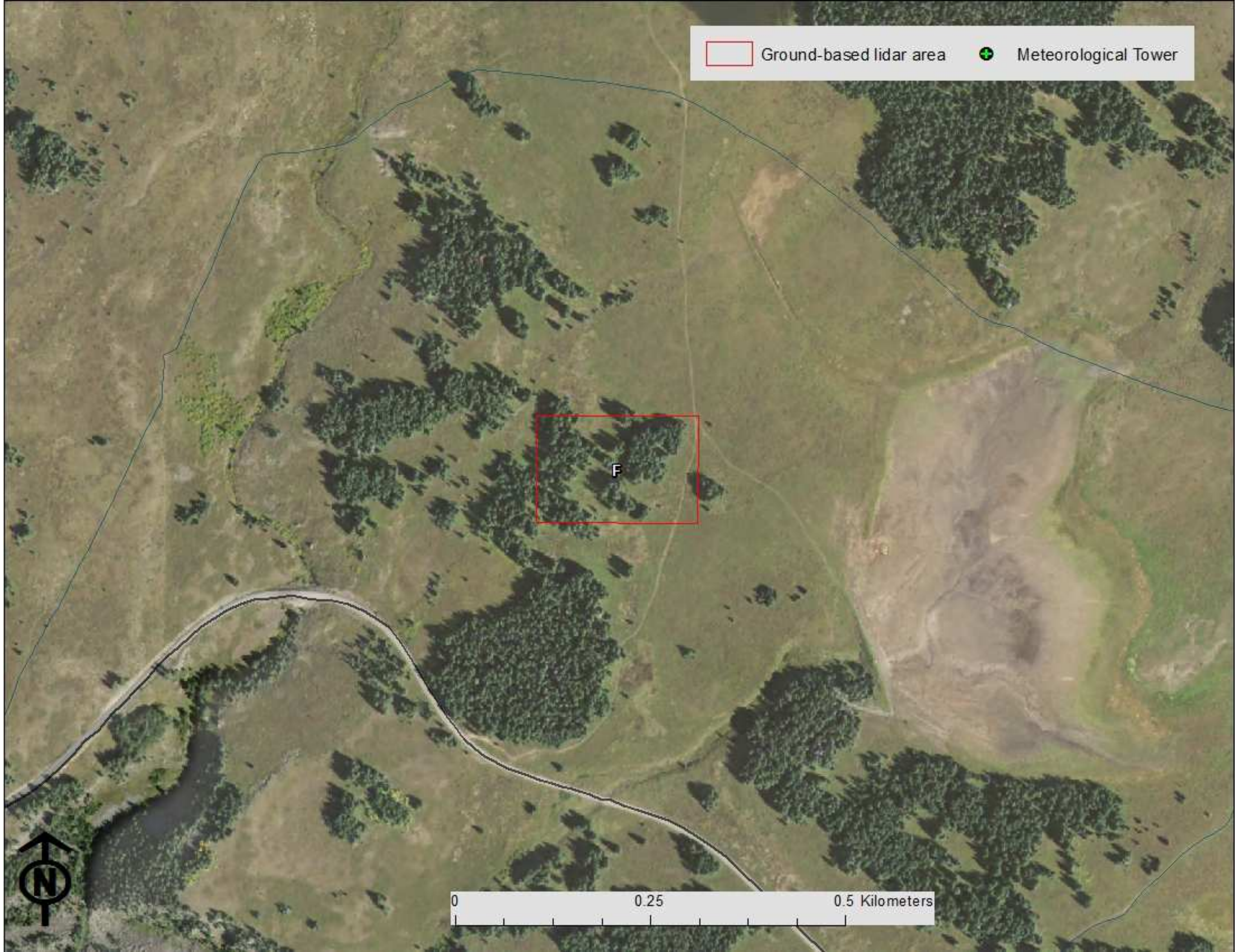


West side, sites A, B, and D



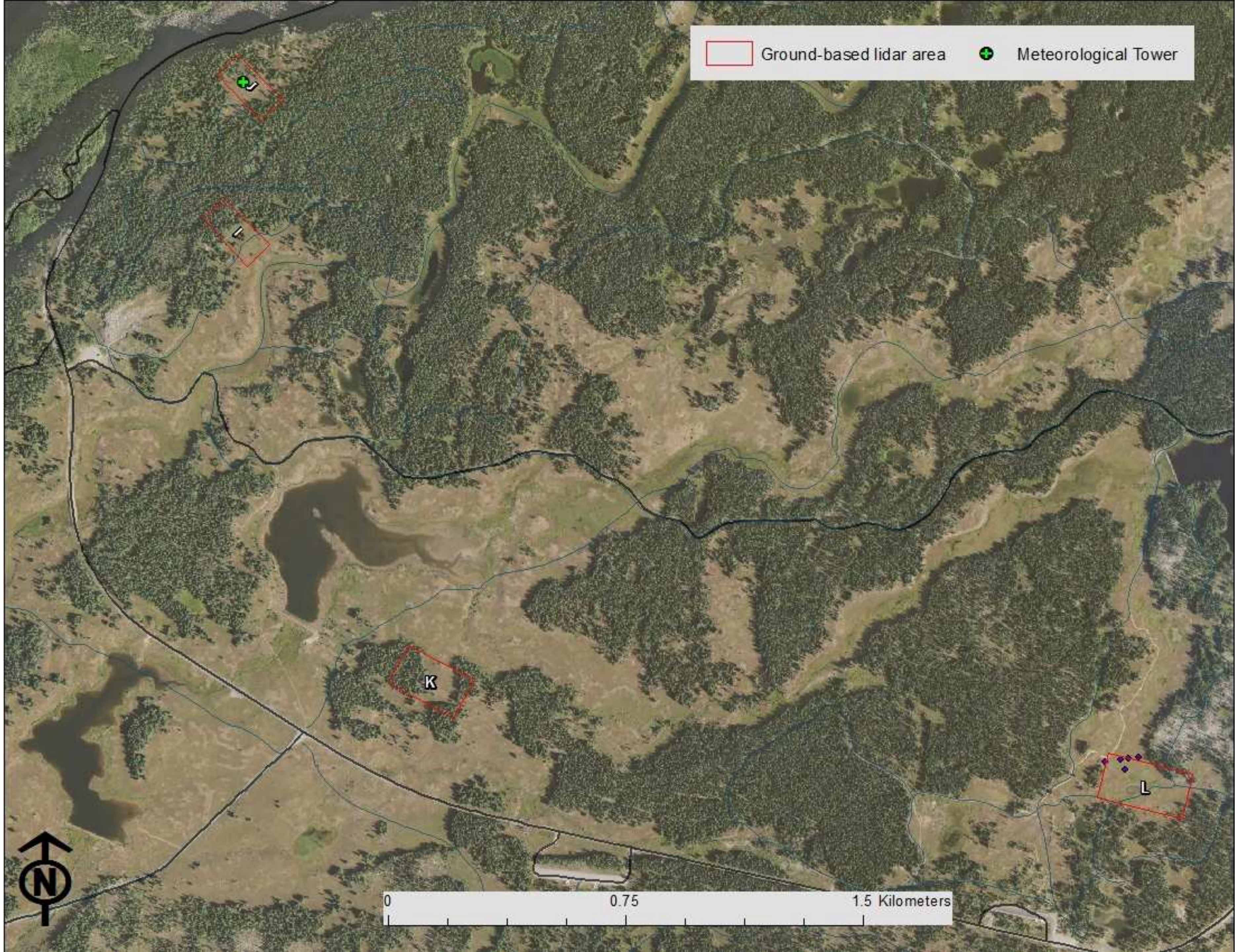
“A” transitions from rocky shrubland to forest, and “B” is *Artemesia* (sagebrush) steppe

West side, site F

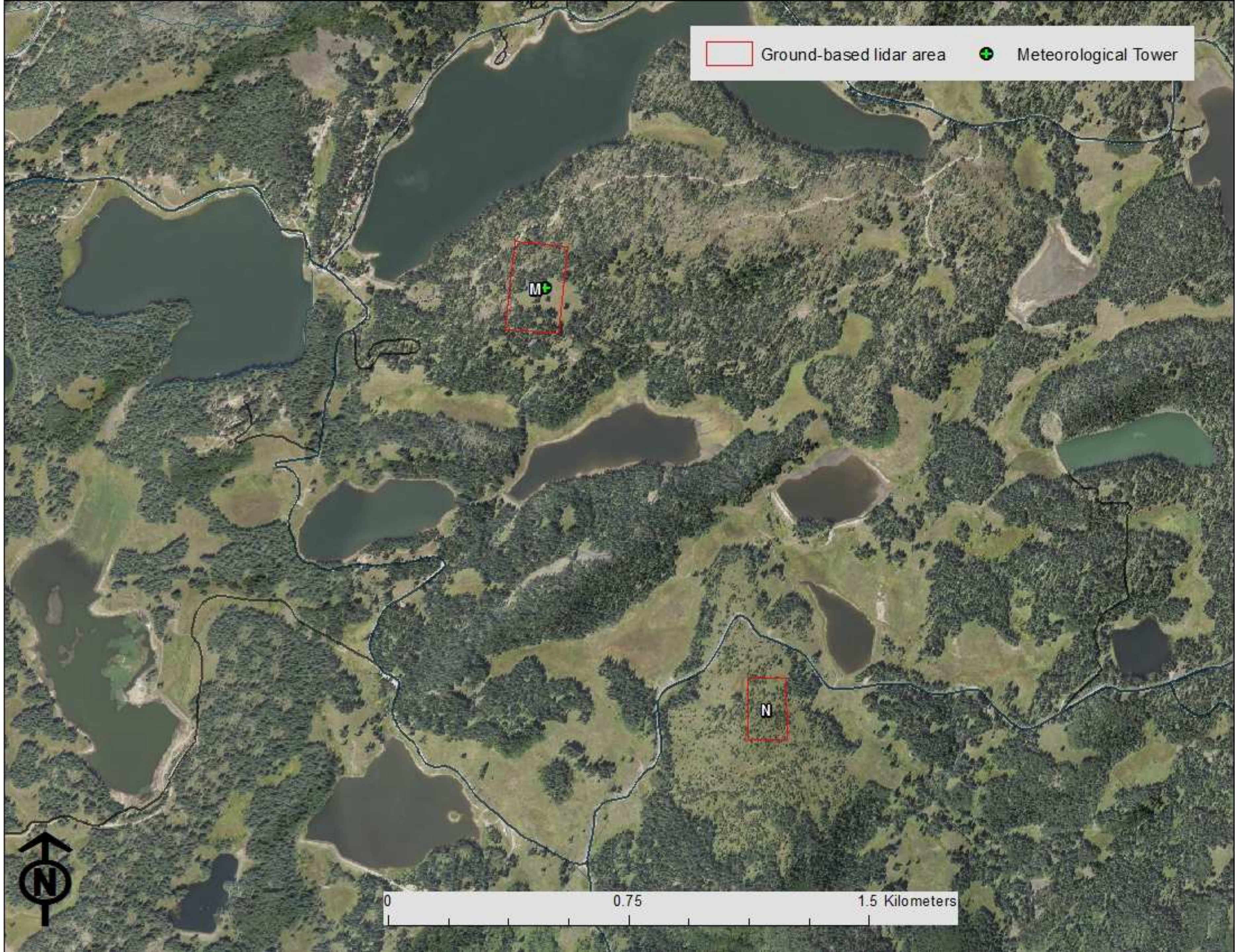


Highway corridor, sites I, J, K, and L.

With the exception of I (active logging), these sites are instrumented. (J has met tower, K has snow sensor network, and L has reflectors)

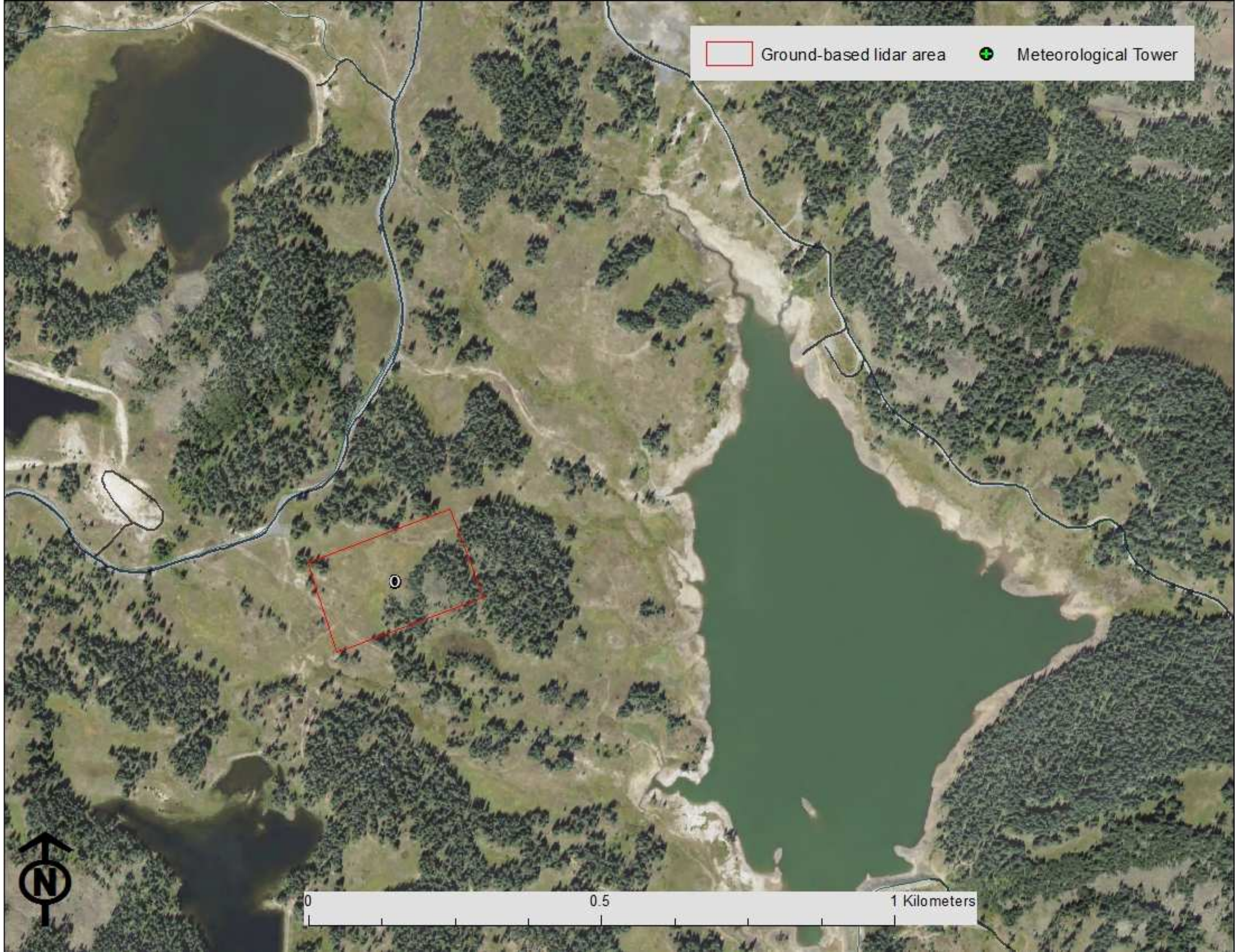


East side, sites M (with met tower) and N

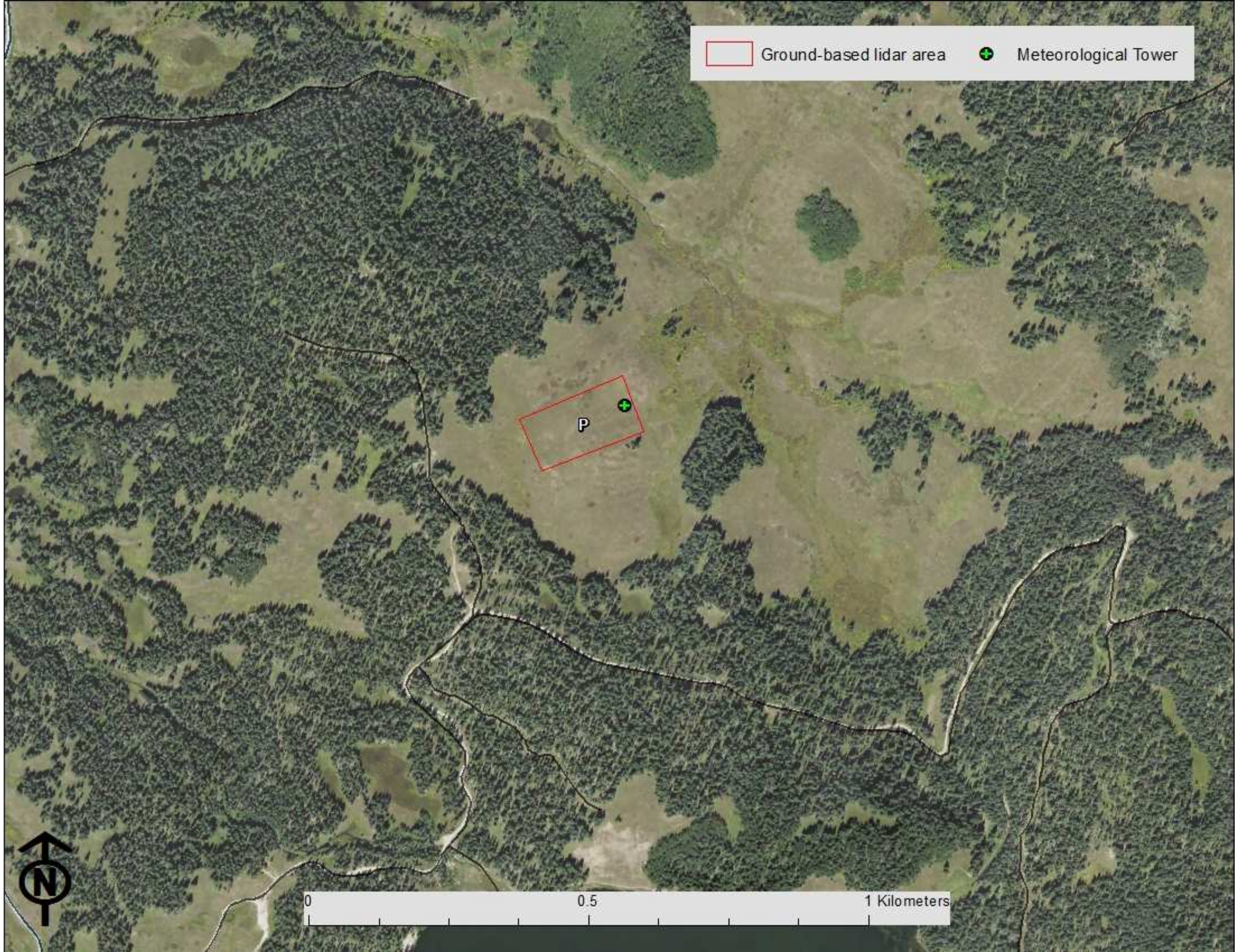


M on the left, hosts a tower
N is lodgepole-dominated

East side, site O



East side, site P (and met tower)



TLS P, open meadow

TLS LSOS and Jumbo Campground

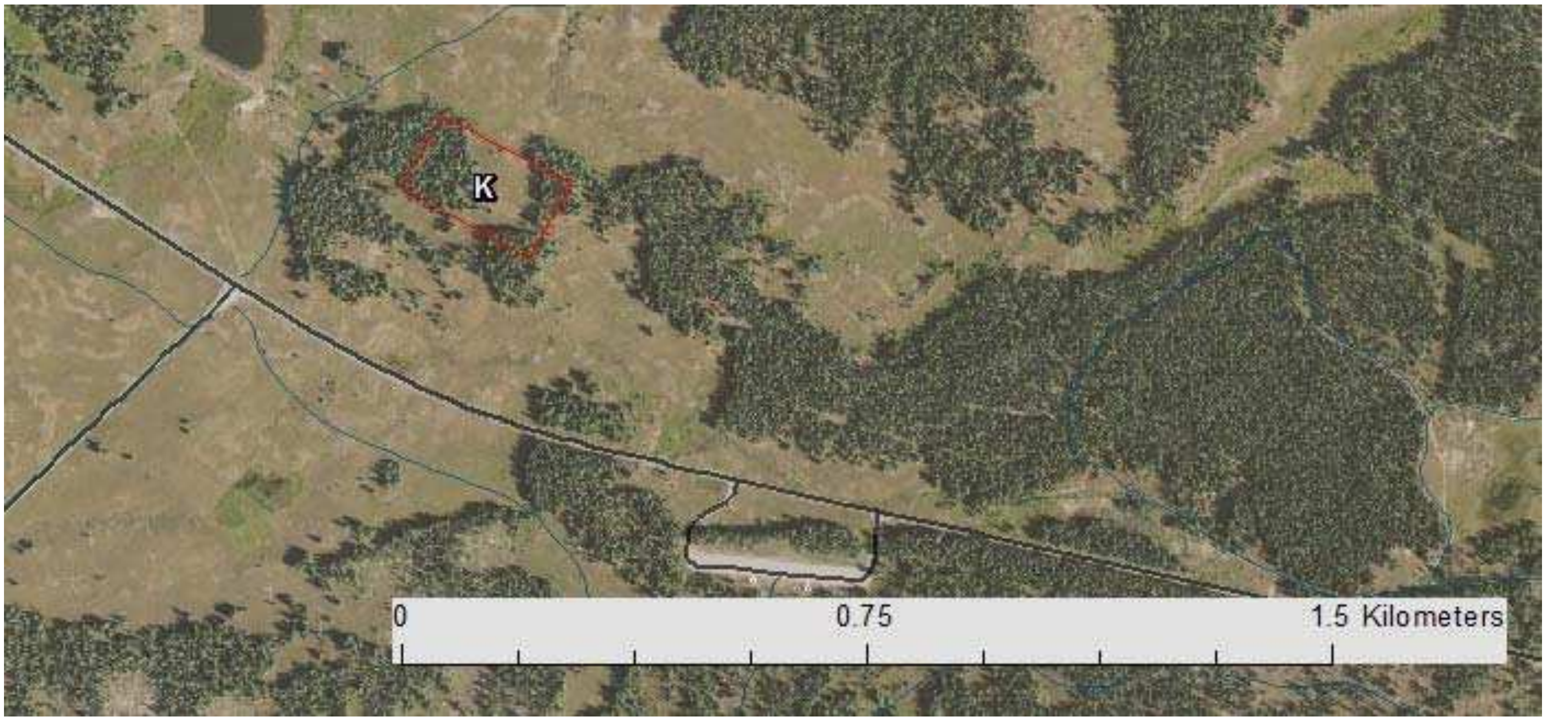
Microwave radiometers
de Roo, U. Michigan

BCAL TLS Group
Boise State

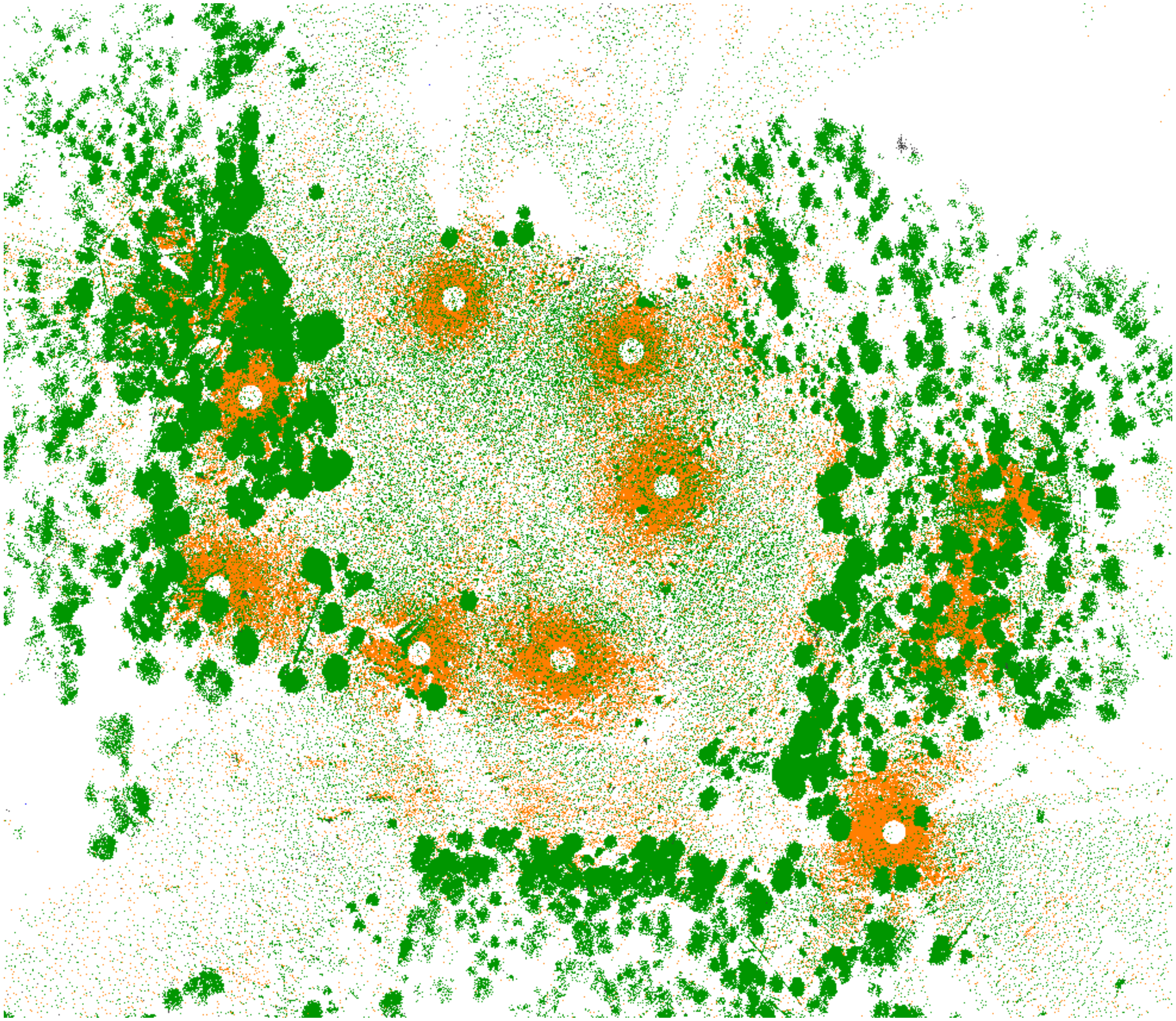
Luke Spaete, Ann Marie Raymondi

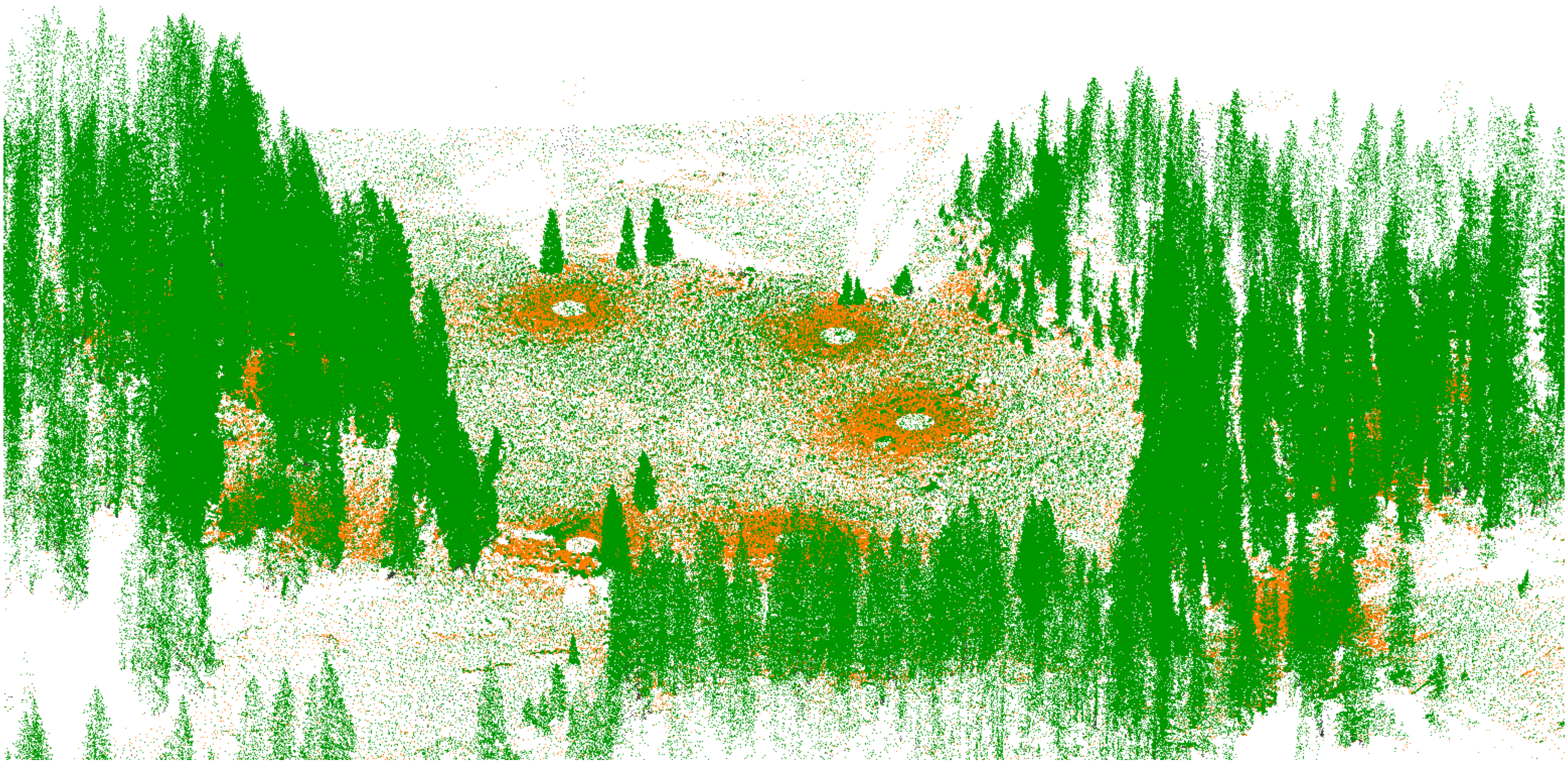
Nancy Glenn, Zach Uhlman, Chris Tennant

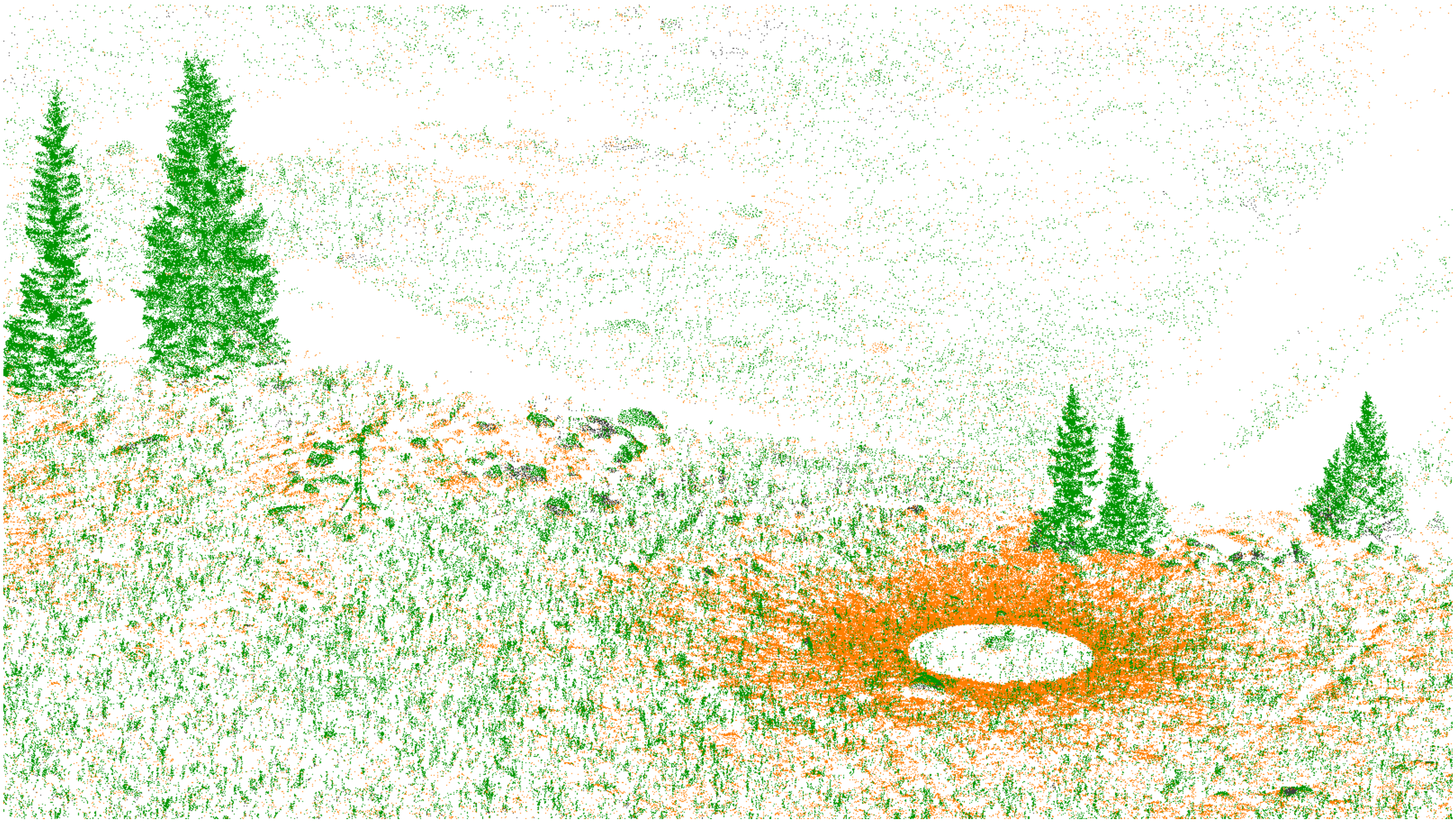
Site K-



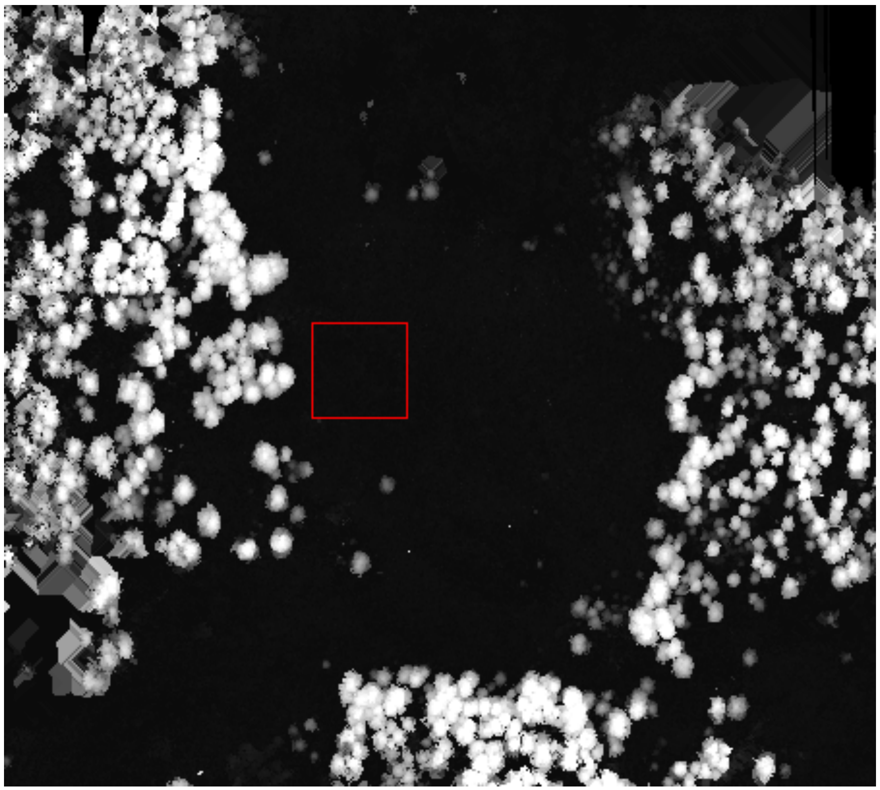
Site K- Point Cloud



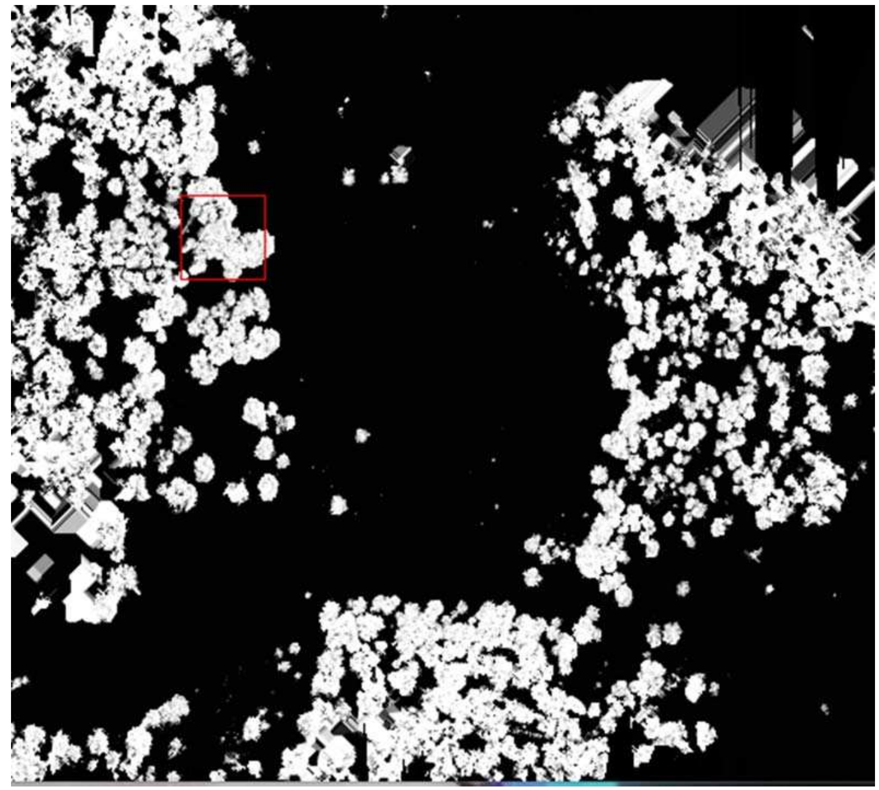




Max Vegetation Height (50cm)



Vegetation Cover (50cm)



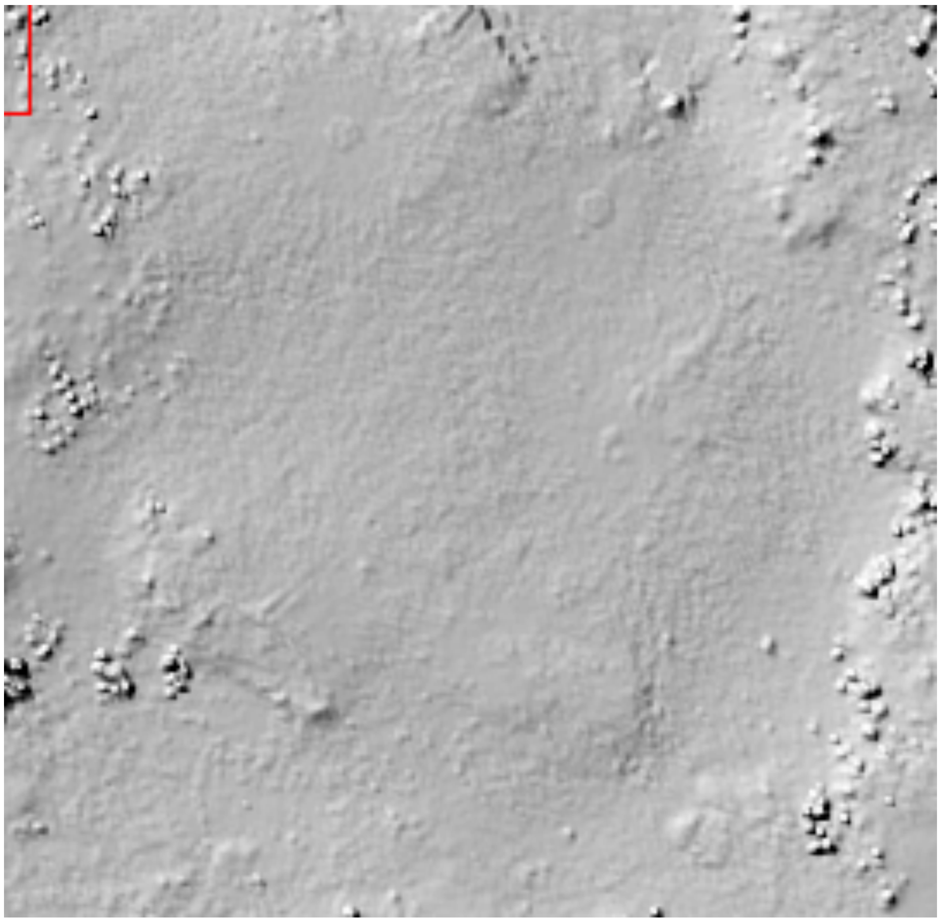
Additional Vegetation Products

•**Minimum Height** - The minimum of all height points within each pixel.
•**Maximum Height** - The maximum of all height points within each pixel.
•**Height Range** - The difference of maximum and minimum of all height points within each pixel.
•**Mean Height** - The average of all height points within each pixel.
•**Median Absolute Deviation (MAD) from Median Height** - The MAD value of all height points within each pixel.
•**Mean Absolute Deviation (AAD) from Mean Height** - The AAD value of all height points within each pixel.
•**Height Variance** - The variance of all height points within each pixel.
•**Height St. Deviation** - The standard deviation of all height points within each pixel.
•**Height Skewness** - The skewness of all height points within each pixel.
•**Height Kurtosis** - The kurtosis of all height points within each pixel.
•**Interquartile Range (IQR) of Height** - The IQR of all height points within each pixel. IQR = Q75-Q25
•**Height Coefficient of Variation** - The coefficient of variation of all height points within each pixel.
•**Height Percentiles** - The 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles of all height points within each pixel.
•**Number of LiDAR Returns** - The total number of all points within each pixel.
•**Number of LiDAR Vegetation Returns** - The total number of all the points within each pixel above crown threshold value (CT).
•**Number of LiDAR Ground Returns** - The total number of all the points within each pixel below ground threshold value (GT).
•**Total Vegetation Density** - The percent ratio of vegetation returns and ground returns within each pixel. Density = nV/nG*100.
•**Vegetation Cover** - The percent ratio of vegetation returns (nV) and total returns within each pixel.
•**Percent of Vegetation in Height Range** Percent of vegetation in height ranges 0-1m,1-2.5m,2.5-10m,10-20m,20-30m,and >30m
•**Canopy Relief Ratio** - Canopy relief ratio = ((HMEAN - HMIN))/((HMAX - HMIN))
•**Texture of Heights** - Texture = St. Dev. (Height > Ground Threshold and Height < Crown Threshold).
•**Foliage Height Diversity (FHD)-All points** -

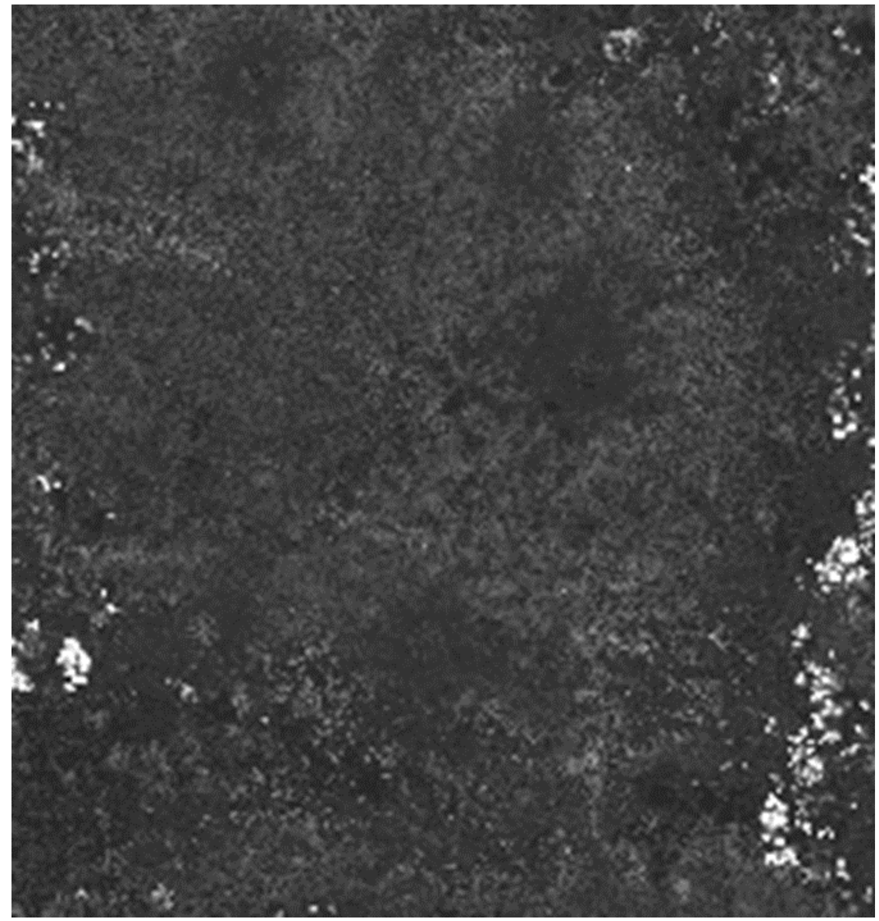
- $$\mathrm{FHD} = -\Sigma p_i \ln p_i$$

where pi is the proportion of the number of lidar returns in the ith layer to the sum of lidar points of all the layers
•**Foliage Height Diversity (FHD)-Points above ground** - FHD calculated only using points above GT

Bare Earth Hillshade (50cm)



Local Roughness* (50cm)



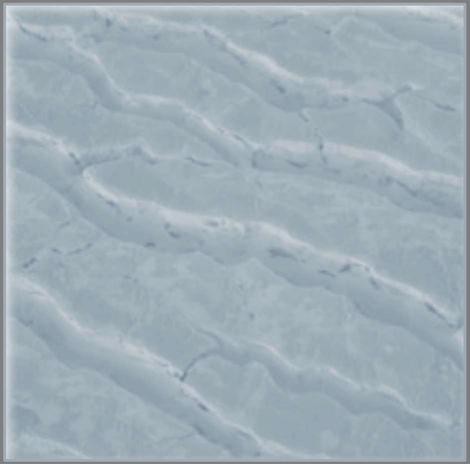
*The roughness (standard deviation) of all bare earth elevation points within each pixel after the local slope has been removed (de-trended)

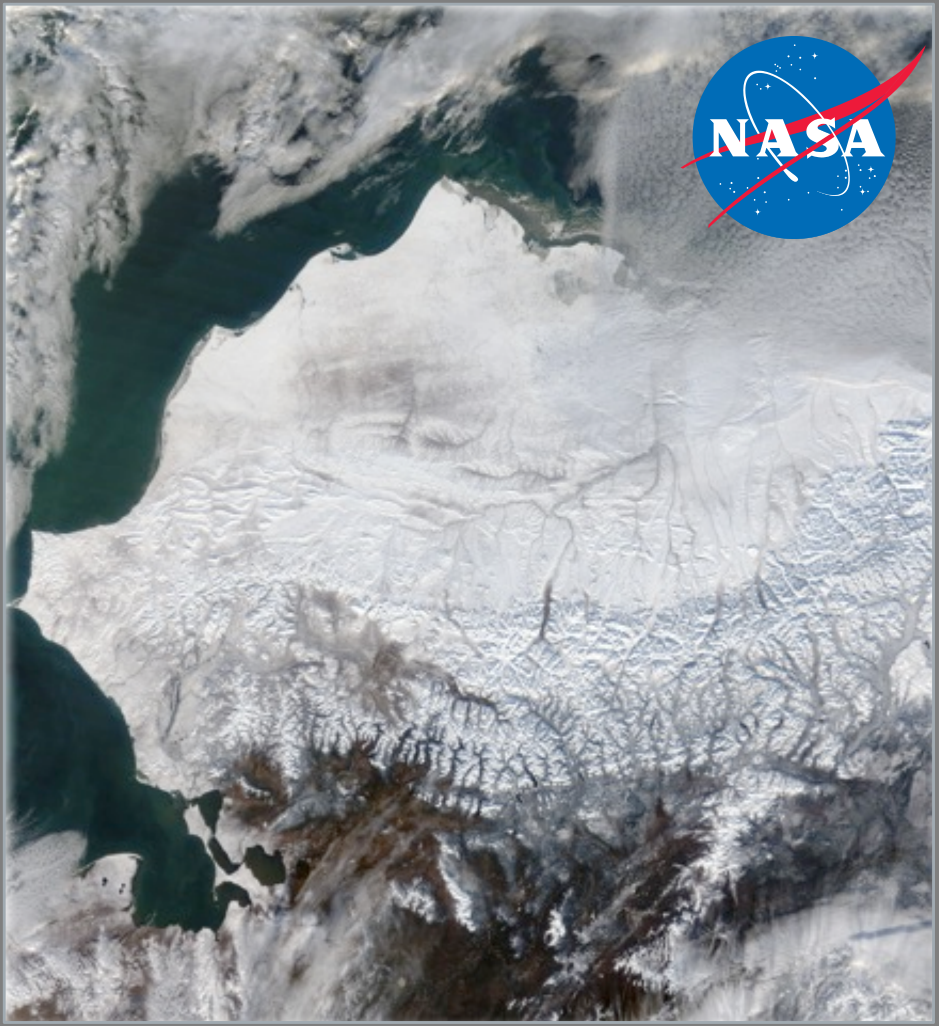
Additional Topo Products

•**Bare Earth Elevation Minimum** - The minimum bare earth elevation (data elevation minus vegetation height) point within each pixel
•**Bare Earth Elevation Mean** - The mean bare earth elevation (data elevation minus vegetation height) of all points within each pixel
•**Bare Earth Elevation Maximum** - The maximum bare earth elevation (data elevation minus vegetation height) point within each pixel
•**Bare Earth Absolute Roughness** - The roughness (standard deviation) of all bare earth elevation points (data elevation minus vegetation height) within each pixel
•**Bare Earth Local Roughness** - The roughness (standard deviation) of all bare earth elevation points (data elevation minus vegetation height) within each pixel after the local slope has been removed (de-trended)
•**Bare Earth Slope** - The average slope of all bare earth points within each pixel in degrees
•**Bare Earth Aspect** - The aspect of the average slope of all bare earth points within each pixel in degrees from North.
•**Bare Earth Topographic Solar Radiation Index (TRASP)**: Transformation of Aspect (TRASP), used by Roberts and Cooper (1989), is defined as (1 - cosine(aspect - 30))/2. TRASP assigns the lowest value to coolest and wettest north-northeastern aspect, and the highest to the hotter, dryer south-southwesterly slopes.
•**Bare Earth Slope Cosine Aspect (Slpcosasp)** - Slpcosasp is calculated as slope x cosine(aspect) (Stage, 1976). This is based on transformation script by Jeffrey Evans.
•**Bare Earth Slope Sine Aspect (Slpsinasp)** - Slpsinasp is calculated as slope x sine(aspect) (Stage, 1976). This is based on transformation script by Jeffrey Evans.
•**Ground Point Density** - The density of ground points within each pixel

DATA MANAGEMENT

Amanda Leon





Data Management

Approach and Data File Recommendations

NSIDC DAAC
Distributed Active Archive Center

National Snow and Ice Data Center
Advancing knowledge of Earth's frozen regions

NSIDC Data Management Approach

- Data management is a spectrum of roles, processes, and outputs in support of making data:
  - Discoverable
  - Accessible
  - Usable
- Data management is collaborative with data producers and users
- NSIDC DAAC has a range of data management service levels to:
  - Align effort levels with the value to the user community (e.g., ROI)
  - Accommodate mission/project requirements or capacity

NSIDC DAAC
Distributed Active Archive Center

DAAC Data Management Activities

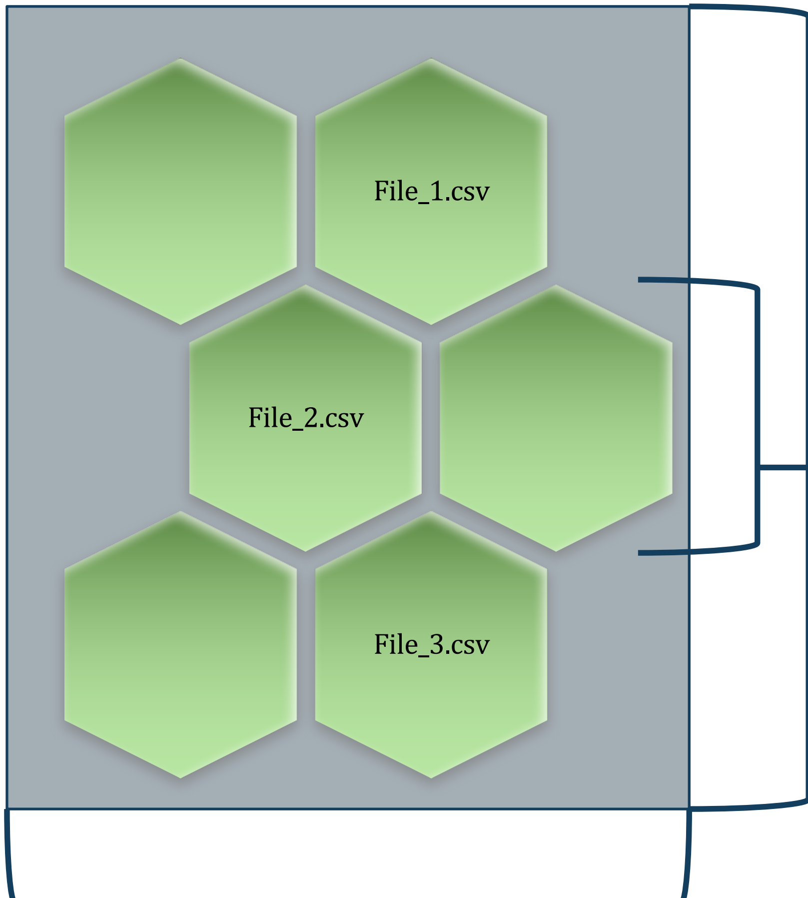
Influenced by:

- Data transfer & ingest
- File-level metadata content & creation
- Data format & structure

NSIDC DAAC
Distributed Active Archive Center

- Develop a Web site
- Develop product user guides and collection-level metadata
  - Content and completeness is dependent on PI contributions
- Provide archival with data integrity checks, redundancy, and direct online access
- Enable data discovery and access
- Provide user support
  - Level of support is dependent on product format, documentation, etc.
- Create data citations and Digital Object Identifiers (DOIs)
- Develop Data Management Plans and Operations Agreements

Metadata terminology



Collection-level metadata

Represents the entire contents and coverage of the data set: platform, instrument, spatial & temporal extent

File-level metadata

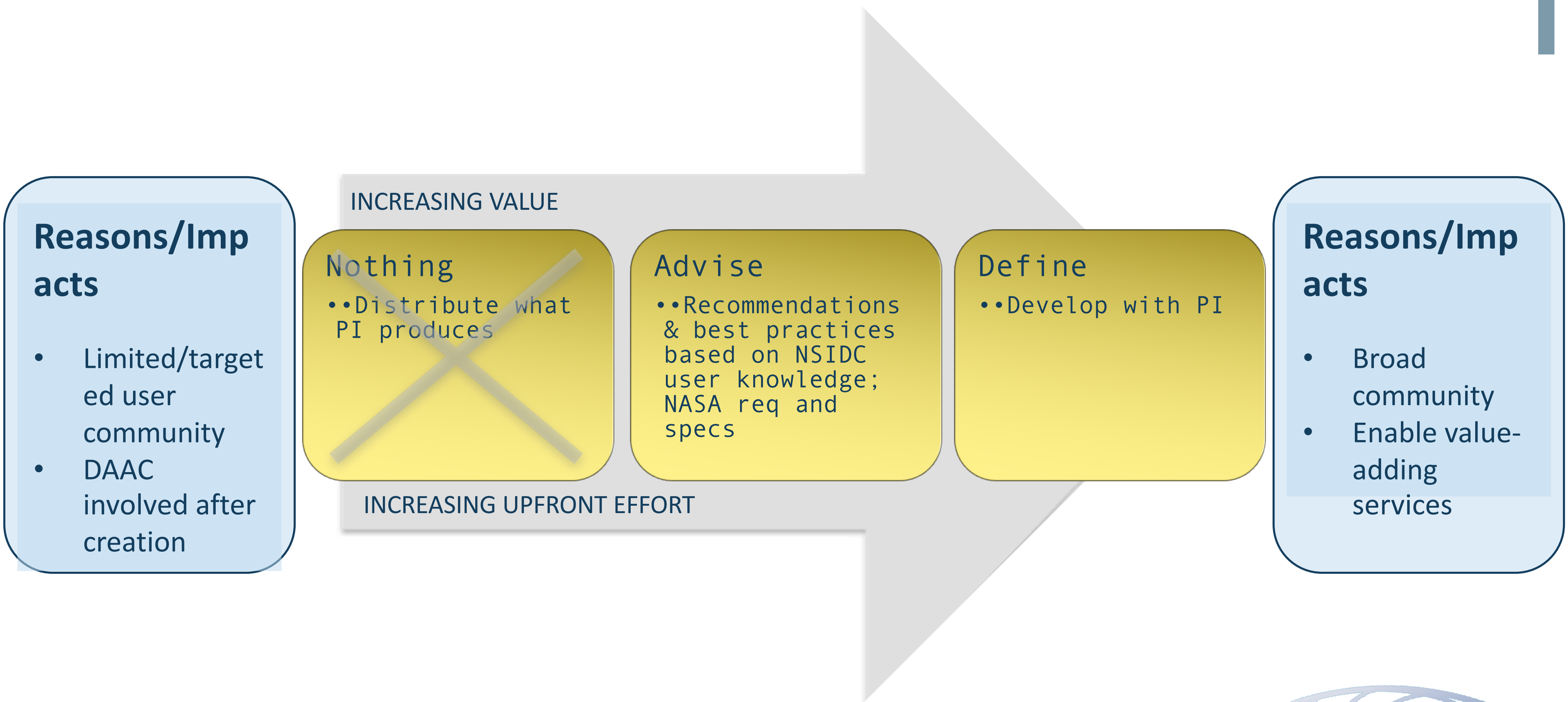
Represents the contents and coverage a single data file: many elements inherited from collection; spatial & temporal extent are

Data set (data product): logically organized data files based on mission/instrument/sensor/measurement/location

NSIDC DAAC
Distributed Active Archive Center

DAAC–Data Provider Decisions

Data Format & Structure



NSIDC DAAC
Distributed Active Archive Center

DAAC–Data Provider Decisions

File-level Metadata Content

for ingest & discovery

Reasons/Impacts

- Limited user community
- General data search and access

INCREASING VALUE

~~None~~

- ~~No longer an option for the NSIDC data system~~

General

- Use collection level metadata: spatial & temporal extent

Specific

- Include file-specific metadata: spatial & temporal extent, campaign, etc.

INCREASING UPFRONT EFFORT

Reasons/Impacts

- Broad user community
- Highly specific data search and access

NSIDC DAAC

Distributed Active Archive Center

DAAC–Data Provider Decisions

File-level Metadata Creation

for ingest & discovery

Reasons/Impacts

- One time data delivery
- Increased time from data receipt to distribution

INCREASING VALUE

NSIDC Batch Creation

- Use MetGen after receiving data and config files from provider

Provider Batch Creation

- Periodically run MetGen on data after processing and before delivery

Provider Continuous Creation

- Implemented as part of data processing system

INCREASING UPFRONT EFFORT

Reasons/Impacts

- On-going data ingest
- Reduced latency for data users
- Complex data best represented by data producers

NSIDC DAAC
Distributed Active Archive Center

DAAC–Data Provider Decisions

Data Transfer & Ingest

Reasons/Impacts

- One time data delivery
- Increased time from data receipt to distribution

INCREASING VALUE

Manual

- Provider delivers data and config files; NSIDC uses MetGen to automate ingest

Batch Automation

- Provider runs MetGen which automates transfer

Continuous Automation

- Data automatically transferred as part of processing

INCREASING UPFRONT EFFORT

Reasons/Impacts

- On-going data ingest
- Reduced latency for data users

NSIDC DAAC
Distributed Active Archive Center

Data File Recommendations

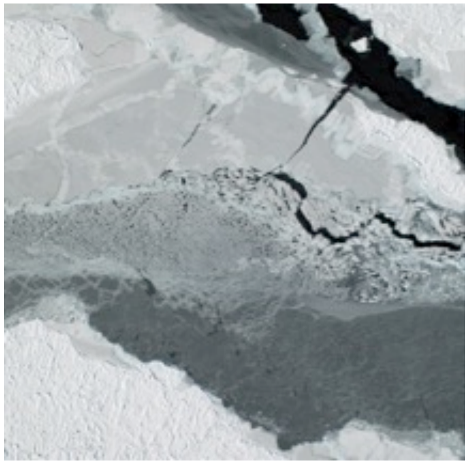
1. **Data formats**
2. **Filenames**
3. **File structure and content**

   Variables → What?

   Time → When?

   Geolocation → Where?

4. **General ASCII/CSV structure**



1. File Formats

- Avoid proprietary formats
  - Challenging for users now
  - May not be readable in the future
- NetCDF & HDF
  - Good for multidimensional data
  - Capable of holding rich metadata
  - Interoperable with variety of computational platforms and protocols (e.g., OPeNDAP)
- GeoTIFF
  - User friendly format; most requested format by NSIDC users
  - Widely interoperable with GIS, image processing, and map server applications
- Shapefile
  - Good for feature data (e.g., points, lines, polygons)

NSIDC DAAC
Distributed Active Archive Center

NASA Earth Science Format Standards

ASCII
https://earthdata.nasa.gov/standards/ascii-file-format-guidelines-for-earth-science-data

HDF5
https://earthdata.nasa.gov/standards/hdf5

HDF-EOS5
https://earthdata.nasa.gov/standards/hdf-eos5

NetCDF-4/HDF5
https://earthdata.nasa.gov/standards/netcdf-4hdf5-file-format

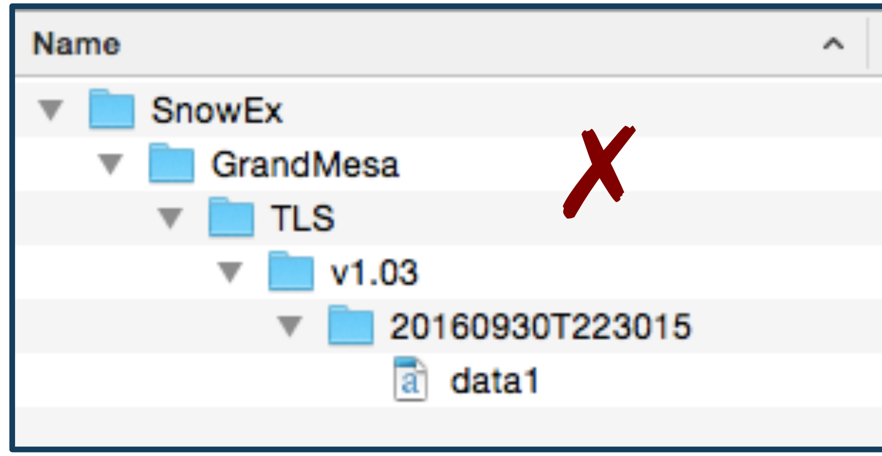
NSIDC DAAC
Distributed Active Archive Center

1. File Formats

Type of data	Recommended formats
Tabular or site-based data	Delimited ASCII/CSV
	HDF
	NetCDF
Raster	GeoTIFF
	HDF
	NetCDF
	Delimited ASCII/CSV
Vector	LAS 1.2 (LAZ)
	Shapefile
	Delimited ASCII/CSV
Photos/Movies	JPEG/MPEG

2. Filenames

- Use descriptive filenames
  - Data set unique identifier (NSIDC generates)
  - Project
  - Instrument
  - Measurement
  - Spatial (site, resolution, etc.)
  - Temporal (date, time, range, resolution, etc.)
  - Processing version
  - Other relevant info



- Filenames must be unique independent of directory structure
- No spaces; ASCII characters only
- File extension indicates data format

NSIDC DAAC
Distributed Active Archive Center

Standard variable names & units

Representation of dates and times

ISO 8601

International System of Units

UDUNITS

Unit database and conversion between units

CF Standard Name

Climate Forecast (CF) standards promote sharing

NSIDC DAAC

Distributed Active Archive Center

3. File structure and content: Variables

- Define unique, interpretable names for each variable
  - Full interpretation can come from a mapping of short variable names to description
- Define units for each variable
- Define a value for missing data and use consistently
  - E.g., -9999, NaN

3. File structure and content: Time

- Define time standard and time zone used
  - Recommend using UTC
  - Timestamps may be reported as UTC decimal seconds from the time at which measurements began (commonly as seconds past midnight)
- Use standard date/time formats
  - Recommend using yyyymmdd, hhmmss, or yyyymmddTHHMMSS.SSSZ (ISO 8601 standard)

NSIDC DAAC
Distributed Active Archive Center

3. File structure and content: Geolocation

- Include geographic coordinates for each measurement in the data file
  - Latitude, longitude, and altitude (where applicable)
- Use a consistent coordinate format
  - E.g., lat/lon decimal degrees, UTME/UTMN
  - Recommend SnowEx select standard format(s) for delivered data products
- Provide coordinate reference system and horizontal and vertical datum

NSIDC DAAC
Distributed Active Archive Center

Full ASCII
Earth Science
Recommendations

https://earthdata.nasa.gov/standards/ascii-file-format-guidelines-for-earth-science-data

NSIDC DAAC
Distributed Active Archive Center

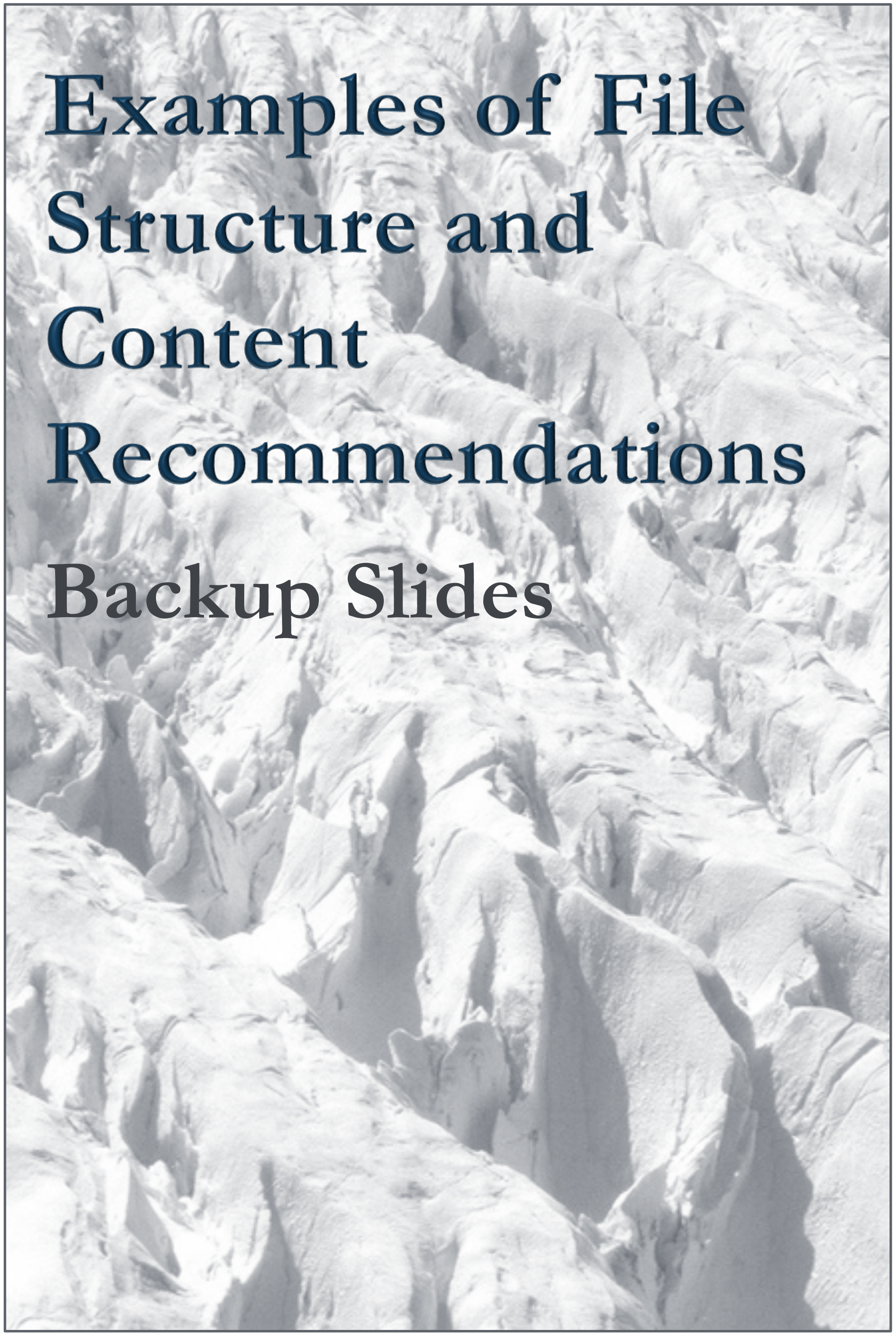
4. General ASCII/CSV Structure

- Include separate header and data sections within file
  - Header needs to be clearly delineated from data rows (e.g., begin with #)
- Use consistent delimiter between data values
  - Visible characters are preferred (e.g., comma, semi-colon, colon, |)
- Separate rows with end-of-line character
  - Mac: CR
  - Unix: LF
  - Windows: CR/LF
- Do not use empty lines or rows

File Recommendations Checklist

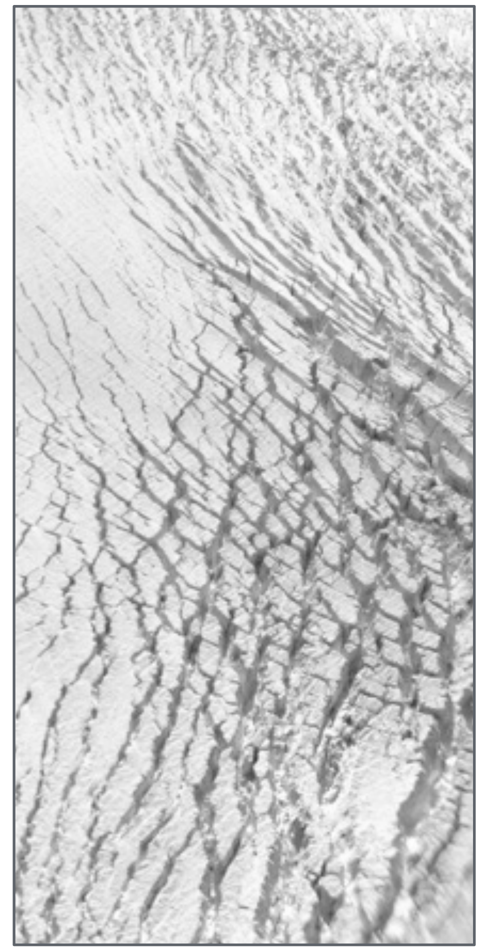
- Data formats
  - Use nonproprietary formats
  - Review the NASA Earth Science format recommendations
- Filenames
  - Use descriptive, unique names
  - No spaces; ASCII characters only
  - File extension indicates data format
- File contents/structure: Variables
  - Unique, interpretable variable names
  - Define units for each variable
  - Consistently use a missing data value
- File contents/structure: Time
  - Define time standard and time zone used: recommend UTC
  - Use standard date/time formats
- File structure/content: Geolocation
  - Include geographic coordinates
  - Use a consistent coordinate format
  - Provide coordinate reference system and horizontal and vertical datum
- General ASCII/CSV Structure
  - Include and delineate header from data section
  - Use consistent delimiter between data values: visible characters preferred
  - Separate rows with EOL
  - Do not use empty lines or rows

NSIDC DAAC
Distributed Active Archive Center



Examples of File Structure and Content Recommendations

Backup Slides



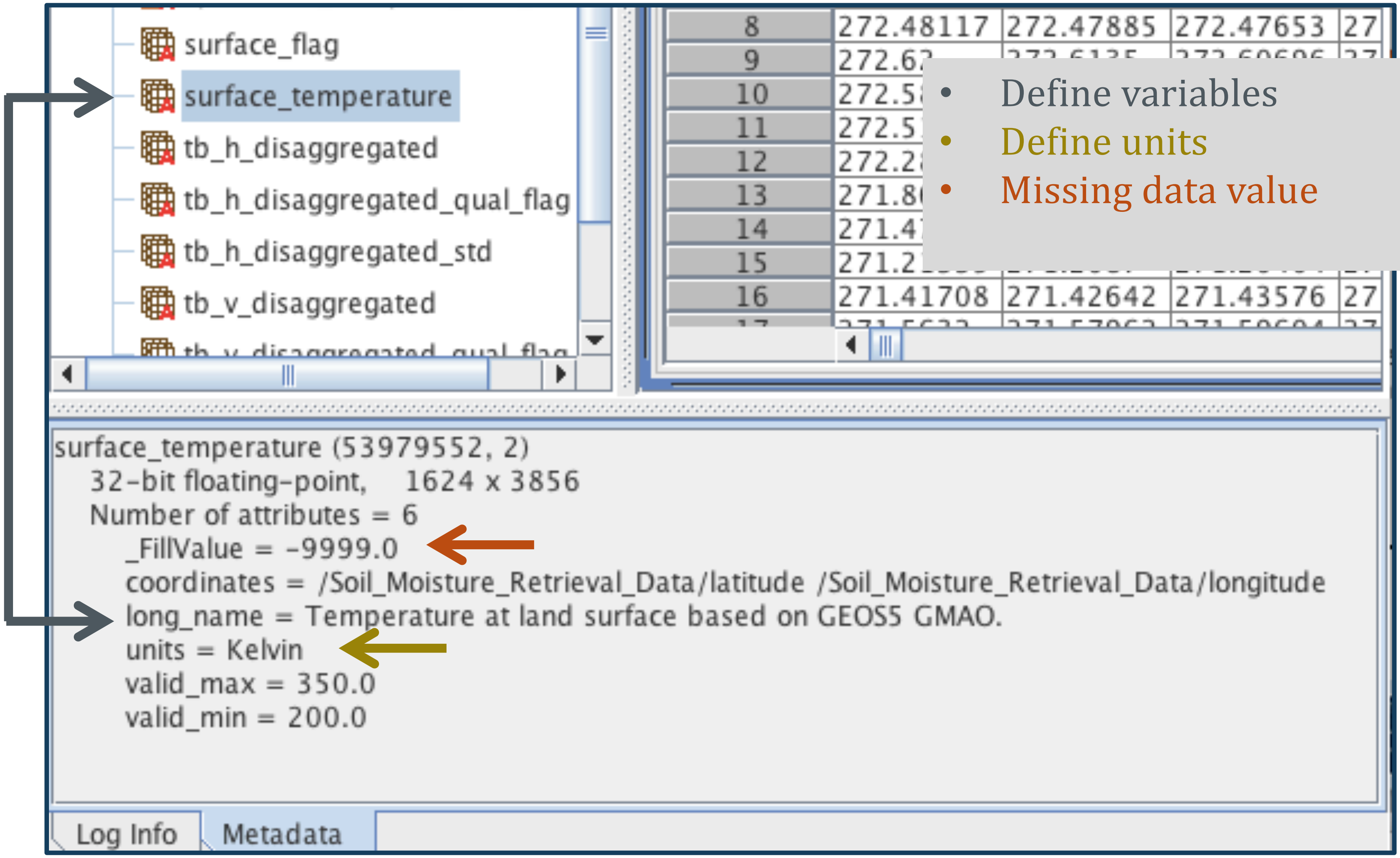
Variables: ASCII Example

	D	E	F	G	H	I	J	K	L	M
1	DATE	TIME	UTME	UTMN	DNS_AVG	DNS_MAX	DNS_MIN	T_AVG	T_MAX	T_MIN
2	MM/DD/YY	HHMM	m		kg/m^3	kg/m^3	kg/m^3	deg-C	deg-C	deg-C
3	3/26/02	1210	424492	4417690	231	246	211	-2	0	-5
4	2/20/03	1530	424532	4417733	228	286	132	-3		
5	3/26/03	1210	424532	4417733	302	389	184	0		
6	3/28/02	1530	424492	4417690	231	268	204	-2		
7	2/22/03	1100	424532	4417733	202	278	56	-3		
8	3/28/03	1400	424532	4417733	273	374	118	-1		
9	3/30/02	1300	424492	4417690	232	265	206	-2		
10	2/24/03	1330	424532	4417733	212	282	87	-3		
11	3/30/03	1300	424532	4417733	283	404	140	0		
12	3/25/02	1100	424492	4417690	279	350	216	0		
13	2/19/03	1210	424545	4417739	227	284	148	-2		
14	3/25/03	1300	424545	4417739	286	401	172	0	0	0
15	3/27/02	1500	424492	4417690	301	371	259	0	0	-1
16	2/21/03	1130	424545	4417739	204	255	103	-2	0	-5
17	3/27/03	1500	424545	4417739	[illegible]	-999	-999	-999	-999	-999
18	3/29/02	1115	424492	4417690	310	353	271	0	0	0
19	2/23/03	1100	424545	4417739	206	279	84	-3	0	-7
20	3/29/03	1330	424545	4417739	306	459	144	-1	0	-6
21	2/25/03	1100	424545	4417739	213	272	102	-2	0	-5
22					340	375	310	0	0	0
23					241	289	180	-3	0	-6
24					289	361	188	0	0	-2
25					247	287	164	-2	0	-6

```
DNS_AVG – pit average density (kg/m^3)
DNS_MAX – pit maximum density (kg/m^3)
DNS_MIN – pit minimum density (kg/m^3)
T_MEAN – pit average temperature (C)
T_MAX – pit maximum temperature (C)
T_MIN – pit minimum temperature (C)
```

- Define variables
- Define units
- Missing data value

Variables: HDF5 Example



- Define variables
- Define units
- Missing data value

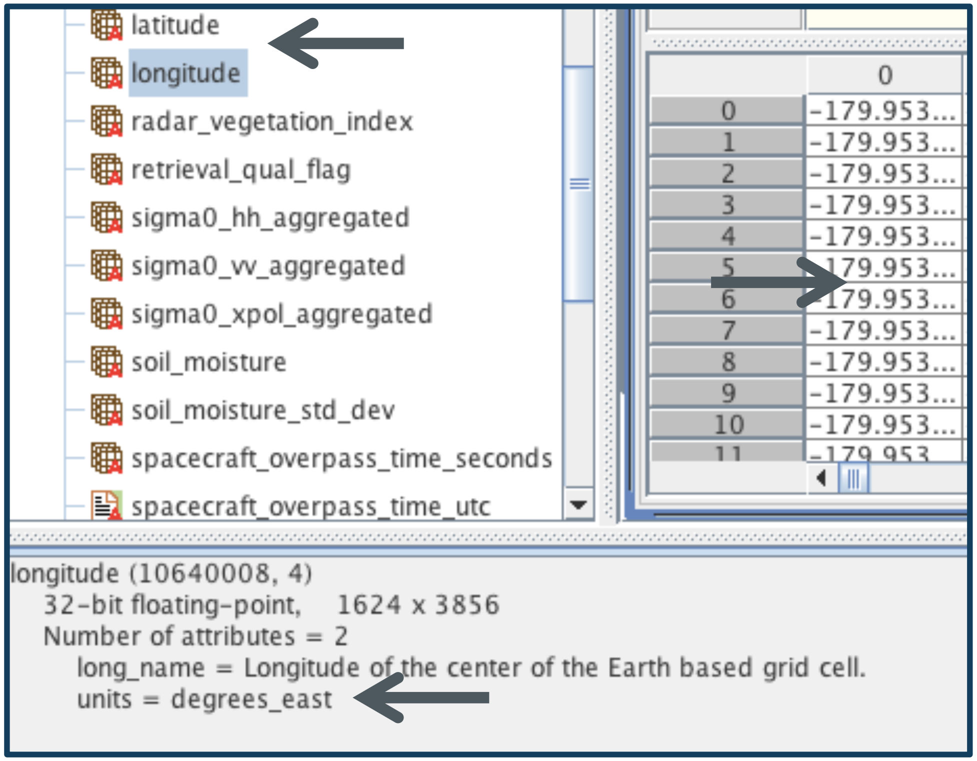
Geolocation: ASCII Example

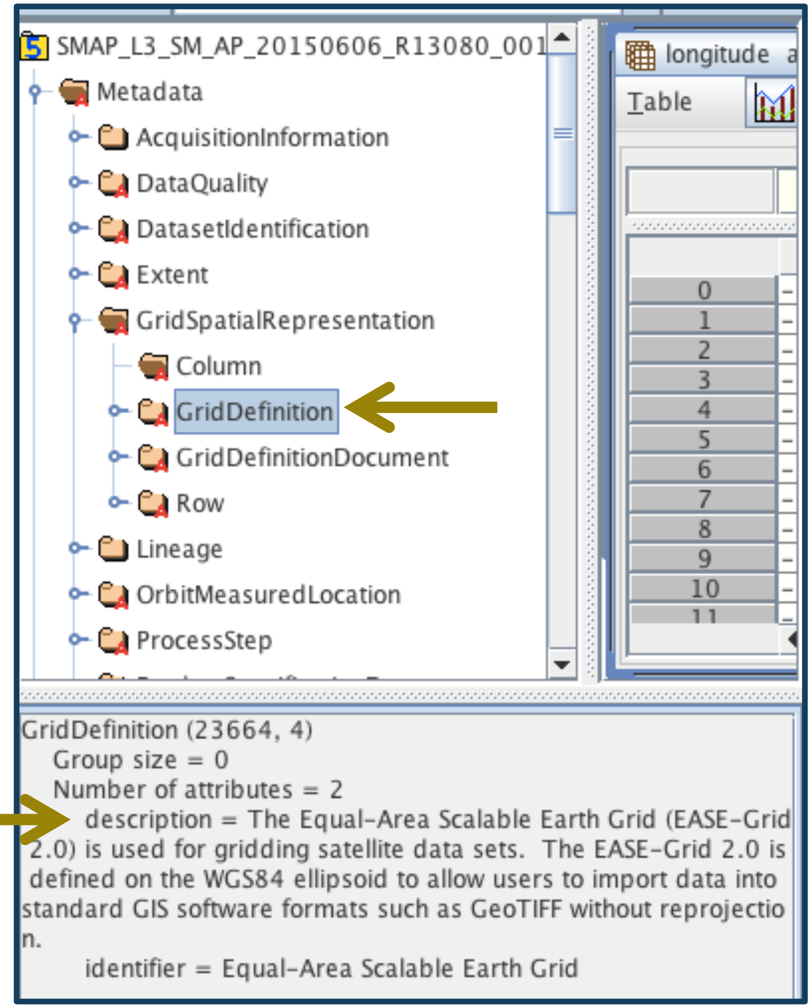
```
#
# NAME        FORMAT   UNITS        DESCRIPTION
#
# ------------------------------------------------------------------------------------------
# LAT         F15.7    degrees      Latitude decimal degrees WGS-84
# LONG        F15.7    degrees      Longitude decimal degrees WGS-84
# DATE        I10      -            Date (YYYYMMDD)
# DOY         I6       -            Day of year
# TIME        F11.2    seconds      UTC seconds past midnight (continous, does not roll over)
# FLT         I8       -            Flight number designated for gravity processing purposes
# PSX         F15.2    m            EPSG:3031 WGS-84 Antarctic Polar Stereographic X
# PSY         F15.2    m            EPSG:3031 WGS-84 Antarctic Polar Stereographic Y
# WGSHGT      F11.2    m            Height WGS-84 (height above GRS80 ellipsoid)
# FX          F15.2    mGal         Gravimeter X acceleration
# FY          F15.2    mGal         Gravimeter Y acceleration
# FZ          F15.2    mGal         Gravimeter Z acceleration
# EOTGRAV     F15.2    mGal         Eotvos and latitude corrected gravity, unfiltered
# FACOR       F11.2    mGal         Free air correction
# INTCOR      F11.2    mGal         Intersection leveling
# FAG070      F11.2    mGal         Free air gravity, 70s
# FAG100      F11.2    mGal         Free air gravity, 100
# FAG140      F11.2    mGal         Free air gravity, 140
# FLTENVIRO   I11      -            -1 = no data, 0 = nor
# ----------------------------------------------------
#
# Notes:
```

```
#
#        LAT          LONG          DATE      DOY     TIME         F
FY            FZ           EOTGRAV       FACOR     INTCOR       FA
      -53.0045550   -70.8456361  20141111   315   36905.00     516    -3929447.88     1364870.15       49.91
-10.74      981300.20          NaN       NaN        NaN        NaN         NaN        NaN        -1
      -53.0045550   -70.8456361  20141111   315   36905.50     516    -3929447.88     1364870.15       49.90
-5.20      981300.37           NaN       NaN        NaN        NaN         NaN        NaN        -1
      -53.0045550   -70.8456359  20141111   315   36906.00     516    -3929447.87     1364870.16       49.90
1.75      981299.13           NaN       NaN        NaN        NaN         NaN        NaN        -1
      -53.0045551   -70.8456358  20141111   315   36906.50     516    -3929447.86     1364870.16       49.89
8.32      981297.06           NaN       NaN        NaN        NaN         NaN        NaN        -1
      -53.0045551   -70.8456358  20141111   315   36907.00     516    -3929447.86     1364870.16       49.88
12.94      981295.03          NaN       NaN        NaN        NaN         NaN        NaN        -1
      -53.0045551   -70.8456358  20141111   315   36907.50     516    -3929447.86     1364870.16       49.88
14.63      981293.88          NaN       NaN        NaN        NaN         NaN        NaN        -1
```

- Define & include geographic coordinates
- Provide coordinate reference system & datum

Geolocation: HDF5 Example





- Define & include geographic coordinates
- Provide coordinate reference system & datum

Time: ASCII example

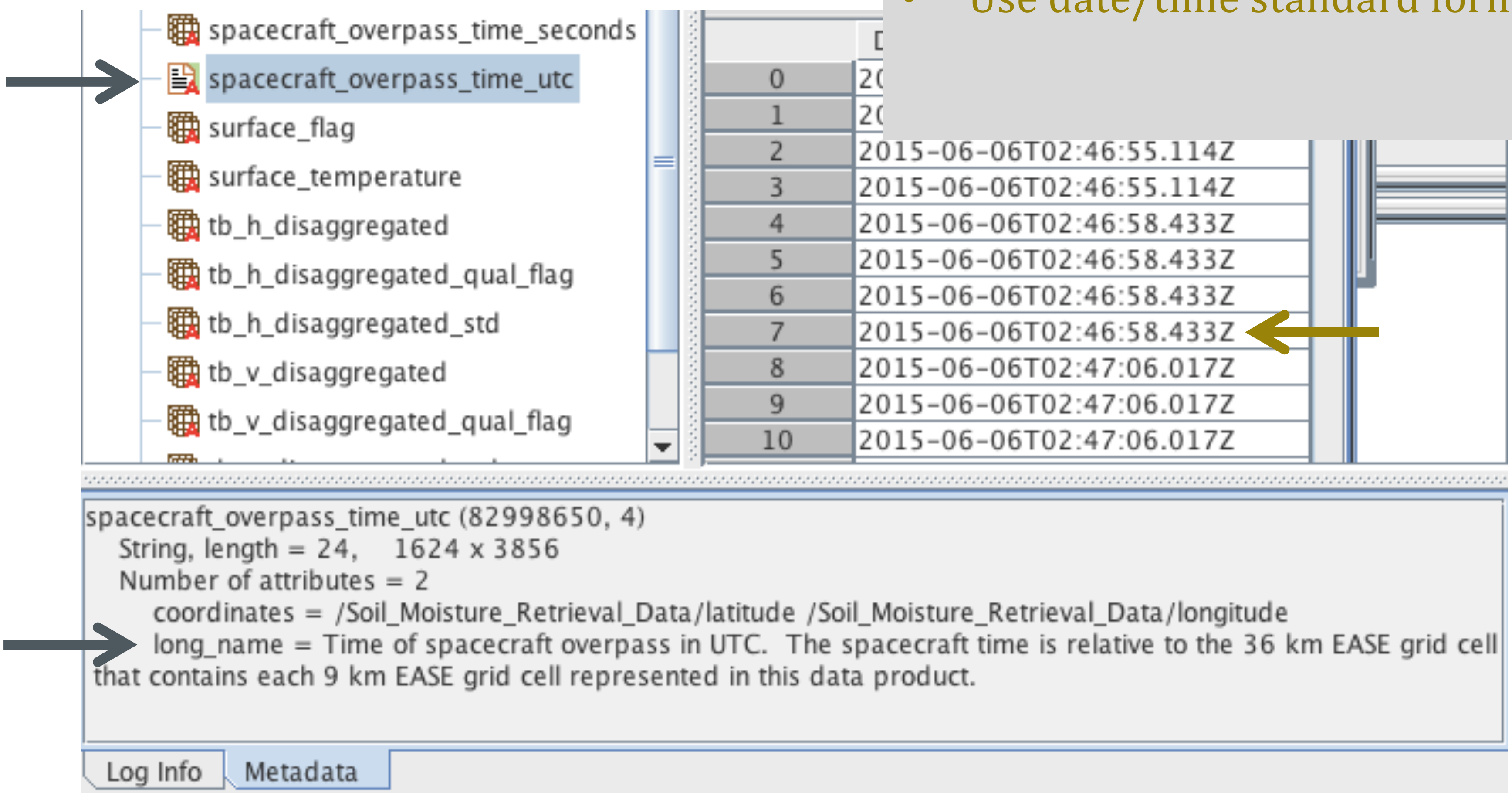
```
#
# NAME        FORMAT   UNITS         DESCRIPTION
# -----------------------------------------------------------------------------------------
# LAT         F15.7    degrees       Latitude decimal degrees WGS-84
# LONG        F15.7    degrees       Longitude decimal degrees WGS-84
# DATE        I10      -             Date (YYYYMMDD)
# DOY         I6       -             Day of year
# TIME        F11.2    seconds       UTC seconds past midnight (continous, does not roll over)
# FLT         I8       -             Flight number designated for gravity processing purposes
# PSX         F15.2    m             EPSG:3031 WGS-84 Antarctic Polar Stereographic X
# PSY         F15.2    m             EPSG:3031 WGS-84 Antarctic Polar Stereographic Y
# WGSHGT      F11.2    m             Height WGS-84 (height above GRS80 ellipsoid)
# FX          F15.2    mGal          Gravimeter X acceleration
# FY          F15.2    mGal          Gravimeter Y acceleration
# FZ          F15.2    mGal          Gravimeter Z acceleration
# EOTGRAV     F15.2    mGal          Eotvos and latitude corrected gravity, unfiltered
# FACOR       F11.2    mGal          Free air correcti
# INTCOR      F11.2    mGal          Intersection leve
# FAG070      F11.2    mGal          Free air gravity,
# FAG100      F11.2    mGal          Free air gravity,
# FAG140      F11.2    mGal          Free air gravity,
# FLTENVIRO   I11      -             -1 = no data, 0 =
# ----------------------------------------
#
# Notes:
```

- Define time standard/zone
- Use date/time standard formats

```
#
#        LAT           LONG          DATE      DOY     TIME         FLT         PSX              PSY           WGSHGT
FY              FZ            EOTGRAV       FACOR     INTCOR      FAG070      FAG100      FAG140   FLTENVIRO
    -53.0045550    -70.8[illegible] 20141111    315   36905.00      516    -3929447.88      1364870.15        49.91
-10.74        981300.20             NaN         NaN           NaN         NaN         NaN         NaN         -1
    -53.0045550    -70.8456361   20141111    315   36905.50      516    -3929447.88      1364870.15        49.90
-5.20        981300.37             NaN         NaN           NaN         NaN         NaN         NaN         -1
    -53.0045550    -70.8456359   20141111    315   36906.00      516    -3929447.87      1364870.16        49.90
1.75        981299.13             NaN         NaN           NaN         NaN         NaN         NaN         -1
    -53.0045551    -70.8456358   20141111    315   36906.50      516    -3929447.86      1364870.16        49.89
8.32        981297.06             NaN         NaN           NaN         NaN         NaN         NaN         -1
    -53.0045551    -70.8456358   20141111    315   36907.00      516    -3929447.86      1364870.16        49.88
12.94        981295.03             NaN         NaN           NaN         NaN         NaN         NaN         -1
    -53.0045551    -70.8456358   20141111    315   36907.50      516    -3929447.86      1364870.16        49.88
14.63        981293.88             NaN         NaN           NaN         NaN         NaN         NaN         -1
```

Time: HDF5 Example

- Define time standard/zone
- Use date/time standard formats



SCHEDULE UPDATES

Amy Misakonis

Winter Schedule

Amy Misakonis

- Airborne
  - NRL CDR: TBD
  - Instrument Readiness Review: 12/5
  - Instruments on deck at PAX: 12/19
  - Instrument integration: 1/3 – 1/11
  - Test Flights: 1/12, 1/13
  - Aircraft arrival in CO: 2/1
  - Campaign Flights: 2/6 – 2/24
- Ground
  - Draft Experiment Plan completed: 11/18
  - All personnel notified and begin onboarding: 11/15
  - All procurements requested: by 12/22
  - All travel booked: by 1/1
  - Team leadership arrival in CO: 2/1
  - All Week 1 arrivals in CO: 2/5
  - Campaign begins: 2/6

UPCOMING MEETINGS & EVENTS

Dorothy Hall/DK Kang/Jessica Lundquist

UPCOMING MEETINGS & EVENTS

AGU FALL MEETING, San Francisco, USA, 12-16 December, 2016
Town Hall: Monday, 12 December: 12:30 - 13:30
Location: Moscone West, 2002
Title: NASA SnowEx - Enhancing new sensing technologies to retrieve snow water equivalent in forested and other lands

4th Winter Field Course for Snow Measurements Kananaskis, Canadian Rockies, Jan 5-9, 2017.

(Application deadline: Nov 18. Decision: Dec 1. http://iswgr.org/fieldwork2017)

IGARSS 2017 MEETING, Fort Worth, Texas, USA, 23-28 July, 2017
http://www.igarss2017.org/default.asp

Paper submission deadline is January 9th, 2017

Invited Session: NASA's SnowEx Campaign: Preliminary Results

Q & A